were noted on other monitoring locations on the perimeter, including the drainage ditch in the Tomasini Triangle that receives non-point source run-off from Point Reyes Station and the Giacomini Ranch feedlots, as well as possible septic influences (Parsons, *in prep*.). The fact that nutrients and pathogen concentrations in the Project Area are sometimes lower than other dairy ranches in the watershed suggests that the high percentage of wetlands already present in the Project Area may be playing some role in improving water quality of drainage ditches and creeks within the pastures (Parsons and Allen 2004a).

Vegetation Resources

Vegetation plays a key and prominent role in wetland functionality. Through providing “roughness” or resistance, vegetation slows down and dissipates the energy of flood flows and traps sediment that carries bound nutrients and contaminants. In addition, vegetation and diversity of vegetation communities is integral to wetlands’ ability to provide habitat for wildlife species for foraging, breeding, nesting, and refugia or protection. Even when plants die or senesce, they continue to support wildlife through export of carbon to the forest floor, streams, or downstream water bodies or by providing tree snags and large woody debris for nesting, roosting, or protection. The strong association of vegetation and wetlands – particularly as the vegetation is often so distinct -- may be one of the primary reasons why wetlands are often perceived as a vegetation resources despite the strong roles played by geology, hydrology, and soils in these dynamic ecosystems.

Regional Setting

As with other areas of western Marin County, the Seashore supports a high number of vegetation communities that are diverse in nature. More than 64 vegetation communities or “alliances” have been mapped within the boundaries of the Seashore and the north district of GGNRA, and the parks are known to support more than 900 plant species. In fact, nearly 18 percent of California's plant species are found in the Seashore. In addition, Point Reyes supports 61 plant species that are actually absent from the rest of Marin County (Howell 1970). The Seashore is also a vegetation transition area, between the Pacific Northwest flora, adapted to cold, wet conditions, and the Mediterranean flora, adapted to hot, dry conditions: Approximately 34 plant species reach their southern limit of distribution here, while Point Reyes represents the northern limit of distribution for another 11 (Howell 1970).

Nearly 18 percent of California’s plant species are found in the Seashore.

This diversity can be attributed in large part to this area’s varied geologic history and structure, hydrology, and climate. Bordered by the San Andreas Fault, movement of the Pacific plate relative to the North American Plate has led to the Point Reyes Peninsula having a community and flora composition that is sometimes distinct from that of the Marin County “mainland.” Tectonic uplifting along the fault has created an incredibly steep, varied, and unstable topography punctuated by ravines along the backbone of the Point Reyes Peninsula that borders Tomales Bay. Topography on the west side of the Inverness Ridge is more gradual as it descends to Drakes Estero and the Pacific Ocean, with many of the higher elevation upland areas characterized by soft, rolling hills.

The geologic instability of this area has produced a diverse array of hydrologic sources for vegetation communities, including isolated lakes, ponds created within “sags” along the fault, and an abundance of groundwater seeps that often serve as sources or “headwaters” for perennially and seasonally flowing streams. These freshwater influences mix with tidal waters from the Pacific Ocean to create estuarine habitats within sheltered embayments and coastlines along the Peninsula’s perimeter. Over geologic time, the Pacific Ocean has alternately encroached upon and retreated from the Marin coastline because of a number of factors, including sea level rise caused by melting of the once extensive glaciers present in North America and land uplift. Not only does this geologic action control the extent of tidal influence in this area, but it has created elevated marine depositional terraces in areas such as the town of Point Reyes Station that are extremely permeable to groundwater seepage. This seepage has created unusual wetland communities that have established on the steep sides of these mesa bluffs.

Superimposed on this geologic matrix are coastal climatic influences that create an extremely mesic or wet environment for vegetation. Unlike more inland areas, the summer season in this Mediterranean climate area often remains very cool due to extended periods of fog or marine layers. Because of this mesic influence, even upland vegetation communities such as coastal prairie often support plant species that, in inland areas, would be more typical of wetland habitats. Moisture is often concentrated within some of the steep ravines or valleys along the Inverness Ridge, leading to development of highly mesic communities dominated by coast redwood (*Sequoia sempervirens*) and Douglas fir (*Pseudotsuga menziesii*) forests on north-facing slopes with more arid shrublands on the opposing south-facing slopes. Point Reyes marks one of the southernmost boundaries of a Douglas fir forest that once stretched continuously from Sonoma County north to British Columbia (Evens 1993). Arid vegetation communities such as chamise (*Adenostoma fasiculatum*)-dominated chaparral and northern coastal scrub are often isolated in areas that receive substantially less fog and rain. While mesic conditions limit the amount of natural fires that occur, chaparral and Bishop pine (*Pinus muricata*)-dominated woodlands are naturally adapted to these often catastrophic events, quickly establishing almost monotypic stands or patches in drier areas of the coast. Point Reyes is one of few areas in California that retains relict stands of Bishop Pine (Evens 1993). The three largest vegetation community alliances in the Seashore and north district of the GGNRA are coyote brush (~17,500 acres), Douglas fir (~17,400 acres), and California annual grassland mapping unit (~15,000 acres).

Regulatory and Policy Setting

Many native vegetation communities within the United States have been adversely impacted by introduction of non-native plant species, as well as a host of other anthropogenic factors such as commercial, residential, and agricultural development, resource extraction, etc. Vegetation in the Project Area has been subject to human activities for 7,000 - 10,000 years, the period believed to be when this area first became occupied by the Coast Miwok. Although data are not available on the effects of Miwok activities on vegetation, it is assumed that they gathered plants for food and for shelter materials and probably used fire to manipulate growth of certain plant species. Beginning in the mid-nineteenth century and continuing into the present, activities such as land clearing, timbering, cultivation, cropping, road building, commercial development and livestock grazing have markedly affected the vegetation.

These activities have affected all vegetation communities, but the most highly publicized and pervasive threats are perhaps those to wetland and riparian communities: in California, more than 91 percent or 4.6 million acres of wetlands have been lost to development, and losses for the rest of the country are estimated at 50 percent (Dahl 1990). Other communities such as California coastal prairie have received less national attention, but the introduction of non-native annual and perennial grasses of European origin have almost extirpated this unique habitat, which may have once dominated large expanses of California's coastline.

In recognition of these threats, federal and state agencies have moved to protect individual species under federal and state Endangered Species Acts (ESA). The California Department of Fish and Game (CDFG) has designated certain types of vegetation communities as deserving of special consideration as special habitats or Natural Communities, although these designations do not carry the same regulatory implications as federal or state listing for endangered, threatened, or rare plant species. Many special status plant and wildlife species either reside in or use some of these sensitive vegetation communities for all or part of their life cycle. Some of these special habitats such as wetlands and riparian areas are often subject to regulatory oversight under the Clean Water Act (federal) or other state and local legislative mandates such as the Porter-Cologne Act, Streambed Alteration Agreement, and Coastal Zone LCP, because of the important role or functions that these habitats provide to both wildlife and humans.

Beyond regulatory mandates, the Park Service Management Policies (2006) require parks to preserve and restore the natural abundances, diversities, dynamics, and habitats of native plant and animal populations and the communities and ecosystems in which they occur (NPS 2001; Section 4.4.1). The Park Service is also specifically urged to not only avoid impacts to wetlands, riparian vegetation, and threatened endangered species, but to look for opportunities to increase, restore, or reintroduce them when these habitats or species have been threatened or extirpated (NPS 2006; Section 4.4.2.3). In addition to protecting and restoring habitats and species affected by non-native species, parks are also moving towards eradication of invasive species that pose substantial threats to the integrity of native habitats and viability of special status plant species populations. Park Service Management Policies (2006) direct parks to manage and, if possible and prudent, eradicate invasive species that interfere with natural processes and the perpetuation of natural features, native species or habitats (Section 4.4.4.2). In addition, "exotic species will not be allowed to displace native species if displacement can be prevented" (Section 4.4.4).

Vegetation Communities

Some preliminary mapping of vegetation communities within the Project Area occurred as part of the Seashore's Park-wide mapping efforts during the late 1990s. Additional vegetation mapping was performed in 2002-2003 within the Study Area to increase the resolution and scope of these preliminary mapping efforts. This information was used to determine the extent and location of sensitive vegetation communities such as wetland and riparian areas, as well as rare Natural Communities designated by the California Natural Diversity Database (CNDDB).

Vegetation communities within the Giacomini Ranch, Olema Marsh, and adjoining areas (Project Area) were mapped using a combination of classification systems (Parsons and Allen 2004b). The Seashore and GGNRA currently rely on a classification system developed by Todd Keeler-Wolf and John Sawyer (1995). However, the type of vegetation communities encountered within the Project Area were not well represented in the Keeler-Wolf and Sawyer classification system, so a modified Holland (1986) system was employed, as well.

The mapping of more than 80 percent of the Project Area as Active Pasture or Agriculture during initial vegetation mapping efforts conducted by the Seashore and GGNRA suggested that the Project Area was primarily a monotypic, pastoral forb-and herb-dominated vegetation community largely shaped by agricultural activities (Parsons and Allen 2004b). However, ground-based vegetation mapping efforts uncovered an incredible amount of habitat diversity in this highly managed landscape (Parsons and Allen 2004b). There were approximately 27 vegetation communities and 99 plant associations (groupings of dominant plant species) mapped within the Giacomini Ranch and Olema Marsh portions of the Project Area (Figure 30; Parsons and Allen 2004b; Ryan and Parsons, *in prep*.). The acreages of the dominant vegetation communities are shown in Table 6, and the most prevalent of these is described in detail later in this section. Most of these communities are wetland- and riparian-associated communities or ones that are ecotonal or adjacent to wetlands and riparian areas. The area's hydrologic complexity undoubtedly accounts for the wide variety of habitats present (Parsons and Allen 2004b; Ryan and Parsons *in prep.*). In addition to the hydrologic, geologic, and climatic forces discussed earlier, vegetation communities within the Project Area have been shaped extensively by historical and current land management practices.

As Table 10 shows, most of the Giacomini Ranch (~ 40 percent) is comprised of Wet Pasture, which is dominated by grass and clover species (Figure 30, Parsons and Allen 2004b). Pasture areas that have subsided and/or are influenced more by saline groundwater or surface water flows have evolved into Salt Marsh Pasture -- combination of salt marsh and pasture species -- and even Diked Salt Marsh (Parsons and Allen 2004b). The predominance of communities such as Wet Pasture, Salt Marsh Pasture, Ruderal, and Disturbed strongly reflects the agricultural nature of the Project Area, although the diversity even within these highly managed habitat types is apparent in names such as "Wet" Pasture and "Salt Marsh" Pasture (Parsons and Allen 2004b).

Areas along the perimeter of the Giacomini Ranch and Olema Marsh where seeps are present or within slow-moving reaches of freshwater creeks support Forested and Scrub Shrub Riparian, Freshwater Marsh, Vernal Marsh, Wet Meadow, and Moist Meadow vegetation communities (Parsons and Allen 2004b, Ryan and Parsons, *in prep*.; Figure 30).

FIGURE 30. VEGETATION COMMUNITIES

TABLE 10. ACREAGES OF THE MOST DOMINANT VEGETATION COMMUNITIES MAPPED IN THE PROJECT AREA

		Giacomini		Olema Marsh		TOTAL	
		Acres	%	Acres	%	Acres	%
1.	Wet Pasture	209.6	38.1	0	0.0	209.6	34.2
2.	Salt Marsh Pasture	87.5	15.9	0	0.0	87.5	14.3
3.	Ruderal	54.3	9.9	0.2	0.3	54.5	8.9
4.	Open Water	45.5	8.3	5.5	8.7	51.0	8.3
5.	Freshwater Marsh	14.3	2.6	36.3	57.6	50.6	8.3
6.	Forested Riparian	17.2	3.1	13.6	21.6	30.8	5.0
7.	Wet Meadow	22.6	4.1	0.3	0.5	22.9	3.7
8.	Tidal Salt Marsh-Mid	20.6	3.7	0	0.0	20.6	3.4
9.	Diked Brackish Marsh-Low	15.04	2.7	0		15.0	2.5
10.	Diked Brackish Marsh-Mid	14.4	2.6	0	0.0	14.4	2.3
11.	Scrub-Shrub Riparian	11.3	2.1	2.3	3.7	13.6	2.2
12.	Mesic Coastal Scrub	12.4	2.3	0	0.0	12.4	2.0
13.	Diked Brackish Marsh-Mudflat/Panne	12.3	2.2	0	0.0	12.3	2.0
14.	Diked Brackish Marsh-High	9.1	1.7	0	0.0	9.1	1.5

Freshwater Marsh systems are very diverse and are characterized by systems dominated by tall and mid-height emergent plant species, as well as low-growing and floating emergent species. Freshwater Marsh is the dominant community in Olema Marsh and lower Bear Valley Creek, followed by Forested Riparian. Due probably to grazing and other land management activities, the percentage of Scrub Shrub and Forested Riparian in and near the Giacomini Ranch is relatively low compared to Olema Marsh and Bear Valley Creek, totaling only 5.2 percent of that portion of the Project Area. However, the presence of groundwater springs on hillslopes adjoining the Point Reyes Mesa has led to establishment of Mesic Coastal Scrub and Scrub-Shrub Riparian communities east of the East Pasture and Tomasini Creek (Parsons and Allen 2004b).

Brackish marsh vegetation communities are also diverse in general, but Tidal Brackish Marsh habitats often consist of extensive stands of tall emergent plant species along the upper reaches of Lagunitas Creek (Parsons and Allen 2004b). Diked Brackish Marsh and Tidal Salt Marsh communities are comprised of varying mixtures of salt marsh species. Within the Giacomini Ranch, Diked Brackish Marsh occurred in low-lying areas or depressions that were formerly tidal channel sloughs (Parsons and Allen 2004b; Figure 30). Prolonged ponding in diked areas that are tidally influenced either directly or indirectly has either precluded or minimized vegetation establishment, creating Mudflat/Panne communities (Parsons and Allen 2004b). Tidal Salt Marsh-Mid communities -- or salt-adapted vegetation communities that typically occur at middle intertidal elevations in salt marshes that are inundated frequently by tides -- occurred on the outer perimeter of the Giacomini Ranch levees and in the undiked marsh north of the Ranch, while Lagunitas Creek accounted for most of the Open Water habitat (Figure 30).

The number of plant associations within most of the vegetation communities is relatively diverse, ranging from only one to as many as 10 associations or groups of plant species (Parsons and Allen 2004b, Ryan and Parsons, *in prep*.). Plant associations represent groupings of particular plant species that commonly occur together, and a particular vegetation community might be composed of several different distinct plant associations. A more detailed description of the dominant vegetation communities and their plant associations is provided below.

While not all non-native plant species are invasive and/or are documented to have negative effects on native plant species communities or wildlife habitats, vegetation communities and plant associations dominated by natives are considered to be more "intact" and likely to support to wildlife through providing habitat, food, and other important relationships, some of which may yet to be documented through existing research. The documented or potential importance of vegetation communities and plant associations dominated by native plant species is one of the reasons that some wetland functionality assessment methodologies include native vegetation communities. Many of the dominant plant associations in the Project Area are dominated or co-dominated by non-native species, some of which were introduced as forage species. Others are aggressive ruderal species that invade areas that are highly disturbed. Dominance and co-dominance are loosely based on definitions in the Seashore vegetation mapping methodology, with native communities considered those with relative cover less than 30 percent (Schirokauer and Parravano 2003). Native species are defined using criteria in the California Invasive Plant Council and/or Jepson Manual (1993) regarding the origin of species (e.g., native, non-native, or naturalized). In general, saline environments tend to support less non-native species, because they are incapable of tolerating highly saline conditions. Brackish vegetation communities and plant associations show a higher proportion of non-native species, however, the number is still limited relative to freshwater environments because of the higher salinities. Common non-native brackish marsh species include brass buttons (*Cotula coronpifolia*) and annual beard grass (*Polypogon monspeliensis*). Because of its history of disturbance and management, the Giacomini Ranch is largely dominated by non-native species, with 467 of the 613 acres present in the ranch and Olema Marsh dominated by non-native species (Figure 31). Despite its history of management and disturbance, Olema Marsh is almost completely dominated by native species, although some non-native species occur in the riparian understory (Figure 31).

Freshwater Vegetation Communities

The historical extent of glycophytic or freshwater vegetation communities within the Tomales Bay watershed is unknown (Parsons and Allen 2004b). The numerous perennial freshwater drainages and sources of groundwater flow present in this region strongly suggest that extensive freshwater habitat occurred in this portion of the Tomales Bay watershed historically (Parsons and Allen 2004b). Groundwater, combined with freshwater drainages flowing off the Inverness and Bolinas Ridges, may have led to formation of extensive freshwater habitat in the Olema Valley upstream of tidal influence, particularly prior to European settlement. The interface between fresh and saline influences was probably even more dramatic historically in southern Tomales Bay, fostered by the combination of fluvial input from several major drainages (Lagunitas, Olema), small drainages (Tomasini, Fish Hatchery, etc.), and seep flow from the Inverness Ridge and Point Reyes Mesa (Parsons and Allen 2004b). The 1863 U.S. Coast Survey maps portray the southern end of Tomales Bay as open water and intertidal mudflat with marsh in the southeastern end in what is today the Giacomini Ranch East Pasture, Olema Marsh, and Olema Creek floodplain. Some historical accounts refer to "Arroyo Olemus Lake" or Olema Lake, which most likely occurred along the low-lying floodplains of Olema Creek between the town of Olema and Lagunitas Creek (Niemi and Hall 1996). This "lake" may have been subsequently drained by construction of the Olema Canal, which straightened the section of Olema Creek between Olema and Lagunitas Creek (Niemi and Hall 1996).

However, at least within the Project Area, it is likely that the extent of freshwater habitat was historically lower than it is today (Parsons and Allen 2004b). While Olema Lake was probably freshwater marsh, tidal marsh appears to have extended into Olema Marsh (Parsons and Allen 2004b), with tidal influence during extreme events reaching Park administrative headquarters (Evens 1993). This suggests that Olema Marsh, which Thomas Howell (1970) once described as "perhaps the best freshwater marsh in (Marin) County," is probably an artifact of levee construction during the late 1800s along Sir Francis Drake Boulevard, also known as Levee Road. Bear Valley Creek flows through the Olema Marsh and then empties into Lagunitas Creek through two culverted drainages just upstream of White House Pool. This marsh, considered the most extensive in Marin County, supports the county's largest red alder (*Alnus rubra*)-willow (*Salix* spp.) stand, which grows alongside substantial patches of cattails (*Typha* spp.) and sedges (*Carex* spp., *Scirpus* spp.) (Shuford and Timossi 1989). As Evens (1993) noted, "by restricting tidal influence, man isolated fresh water from salt and created freshwater habitats ... where brackish marsh must have existed before."

FIGURE 31. NATIVE AND NON-NATIVE VEGETATION COMMUNITIES

Within the Giacomini Ranch, an artificially fresh regime has been reinforced, at least within the Project Area, by diking of Lagunitas Creek and minimization of tidal inflow into the pasturelands through one-way tidegates. Freshwater influences have been augmented by spray and flood irrigation in the East Pasture and possible enhancement of groundwater flow from Inverness Ridge and Point Reyes Mesa by septic discharges. The extensive freshwater marsh that exists in the northern portion of the West Pasture today is not even visible in the 1942 aerial photograph taken before the area was diked, suggesting that freshwater marsh conditions have been strongly promoted by the levee and possibly septic influences from houses on the Inverness Ridge.

Wet Pasture in the East Pasture, looking north

Wet Pasture *(Parsons and Allen 2004b)*: A large percentage (38 percent or 210 acres) of the Giacomini Ranch has been mapped as Wet Pasture, particularly the southern and eastern portions of the East Pasture (Table 6; Figure 30; Parsons and Allen 2004b). Wet Pasture is a glycophytic grassland community dominated (> 50 percent) by grasses and herbs that are predominantly facultative or obligate hydrophytes or wetland species.

Freshwater hydrologic sources for this community include bank overflow from small drainages, surface or subsurface movement of groundwater "seep" flow, surface runoff, artificial flooding by spray or flood irrigation, and precipitation.

Clumps of tall emergents such as cattails and bulrush occur amidst a blanket of low-growing species such as hydrocotyle and water parsley in the West Pasture's Freshwater Marsh

Wet Pasture areas are either actively managed as pasture through seeding, irrigation, mowing, leveling, etc., or contain some of the predominant pastoral or forage species such as creeping bent grass (*Agrostis stolonifera*), rough bluegrass (*Poa palustris*), white clover (*Trifolium repens*), and strawberry clover (*Trifolium fragiferum*). Other non-native grass species present included Mediterranean barley (*Hordeum marinum*), perennial ryegrass (*Lolium perenne*), annual ryegrass (*Lolium multiflorum*), and tall fescue (*Festuca arundinacea*). Some native plant species occurred, as well, such as meadow barley (*Hordeum brachyantherum*), water foxtail (*Alopecurus geniculatus*), meadow foxtail (*Alopecurus pratensis*), western mannagrass (*Glyceria occidentalis*), and blue wildrye (*Leymus triticoides*).

Freshwater Marsh *(Parsons and Allen 2004b)*: The minimization of tidal flow through levees and tidegates, combined with strong freshwater influences from drainages, seeps, and irrigation, has encouraged establishment of Freshwater Marsh in some portions of the Project Area. Freshwater Marsh is characterized as freshwater areas dominated by more than 70 percent of persistent sedges, rushes, and other non-clover herbs that are inundated or saturated nearly year-round. Most of the freshwater marshes within the Project Area have developed in slow-moving drainages, drainage ditches, and ponds that have been highly disturbed by cattle or other agricultural activities. The size of this vegetation community is relatively small in the Giacomini Ranch, totaling only 14 acres or 3 percent of this portion of the Project Area. Conversely, this was the dominant community in Olema Marsh and lower Bear Valley Creek, representing 36 acres and 58 percent of this portion of the Project Area.

The large freshwater marsh in the northern portion of the West Pasture is a large (~7.2-acre) seep– and drainage-fed marsh dominated by tall emergent freshwater marsh species such as bulrush (*Scirpus californicus*), cattails (*Typha spp.),* bur-reed (*Sparganium erectum* var. *stoloniferum*), rush (*Scirpus americanus*), as well as low-growing species such as rush (*Juncus balticus* and J. *phaeocephalus*), hydrocotyle, water parsley, creeping bent grass (*Agrostis stolonifera*), western mannagrass, and sedges (*Scirpus pungens* and *S. microcarpus*). The tall emergent species such as cattails, bulrush, bur-reed, etc., typically occur in dense, almost monotypic clumps that are spatially separated from each other by a dense blanket of low-growing emergent species such as hydrocotyle, water parsley, and sedge (*Scirpus pungens*). Hydrologic conditions are maintained by small perennial drainages that flow onto the gradually sloped surface from the south and west (under Sir Francis Drake Boulevard) and groundwater from the Inverness Ridge, as well as occasional tidal flooding.

The largest freshwater marsh in the Project Area is Olema Marsh (Ryan and Parsons, *in prep*.). Olema Marsh, once described as "perhaps the best freshwater marsh in the county" (Howell 1970), is dominated by tall emergent moncots, such as cattails (*Typha latifolia* and *angustifolia*), bulrush, hardstem bulrush (*Scirpus acutus*), and sedges (*Scirpus microcarpus*), with lesser amounts of low-growing species such as rush, hydrocotyle and water parsley. Lower Bear Valley Creek is also largely freshwater marsh habitat due to its flat gradient, but with a higher percentage cover of floating or low-growing plant species (Ryan and Parsons, *in prep*.). Marsh conditions were once maintained through annual burning of willows by the Bear Valley Country Club (Evens 1993). The freshwater marsh habitat in Olema Marsh and lower Bear Valley Creeks is sustained by perennial creek flow from Bear Valley Creek, as well as seasonal and perennial flow from drainages and groundwater originating from the Inverness Ridge (KHE 2006a). The culverts at Levee and Bear Valley Roads, in addition to remnants of historic fill activities near Levee Road, have largely precluded tidal influence in these once tidal areas and may be negatively impacting riparian habitat along the perimeter through impoundment of waters and steadily increasing water surface levels (KHE 2006b, Ryan and Parsons, *in prep*.).

Wet Meadow *(Parsons and Allen 2004b)*: Wet Meadows support at least 30 percent cover of sedge, rush, or other non-clover herbs, as well as grasses. Typically, dominant sedge and rush species are the short- to medium-sized species, as opposed to cattails, tules, and bulrush. Species include freshwater and/or brackish ones such as spikerush (*Eleocharis macrostachya*), hydrocotyle, rush (*Juncus balticus*, *J. effusus*, and *J. lesueurii*), pennyroyal (*Mentha pulegium*), white clover (*Trifolium repens*), water foxtail, western mannagrass, creeping bent grass (*Agrostis stolonifera*), and perennial ryegrass, as well as occasionally sedge (*Scirpus microcarpus*), monkeyflower (*Mimulus guttatus*), and water cress (*Rorippa nasturtium-aquaticum*). Inundation or saturation with water often extends throughout the spring into at least the early summer. Wet Meadow habitat occurs principally in the West Pasture along the sloped perimeter of the Inverness Ridge where groundwater emerges from the base of the Inverness Ridge and sheetflows across or just below the soil surface. In terms of area, Wet Meadow habitat represents a moderately large proportion of the Project Area (3.5 percent), with area totaling 23 acres.

Scrub-Shrub and Forested Riparian *(Parsons and Allen 2004b)*: Scrub-shrub and Forested Riparian communities primarily occur along the western boundary of the West Pasture, the southern portion of Lagunitas Creek; Wildlife Conservation Board lands near White House Pool and the Green Bridge; lower Bear Valley Creek; the perimeter of Olema Marsh; and along limited portions of Tomasini and Fish Hatchery Creeks and other small drainages. Most of these riparian communities are hydrologically influenced by headwater or backwater freshwater flooding along creeks and/or tidal flooding in brackish portions of creeks. However, in response to strong groundwater gradients from either the Inverness Ridge or the Point Reyes Mesa, a riparian fringe has established along the western and eastern perimeters of the Giacomini Ranch and the western perimeter of Olema Marsh also receives groundwater flow from either Inverness Ridge or the Point Reyes Mesa.

Within the Project Area, the riparian vegetation communities generally reflected the low stream and valley slope gradient present with red alder and arroyo willow the dominant species. Other species present are box elder, California buckeye (*Aesculus californicus*), eucalyptus (*Eucalyptus globulus*), California bay (*Umbellularia californica*), coast live oak (*Quercus agrifolia*), and shining willow (*Salix lucida* ssp. *lasiandra*). Dominant understory species included California blackberry (*Rubus ursinus*), thimbleberry (*Rubus parviflorus*), stinging nettle (*Urtica dioica*), and horsetail (*Equisetum* spp.). In addition to eucalyptus, a few potential invasive species were also observed such as Himalayan blackberry (*Rubus discolor*), greater periwinkle (*Vinca major*), and Cape ivy (*Delairea odorata*), although the total percent cover of these species was very low, and they were relegated for the most part to the riparian strip along Sir Francis Drake that adjoins the Inverness Park residential area.

Forested Riparian habitat consisting of mature red alder and arroyo willow stands along northern portion of Fish Hatchery Creek adjacent to Sir Francis Drake Boulevard

Grazing has eliminated riparian habitat along most of the drainages within the pastures themselves, although some sapling-sized arroyo willows (*Salix lasiolepis*) and red alders (*Alnus rubra*) are trying to establish at the southern end of Fish Hatchery Creek. In addition to agricultural impacts, riparian habitat along Lagunitas Creek may be affected by upstream hydrologic alterations such as dams, mining, and groundwater withdrawal. By decreasing the magnitude of peak flows, increasing the duration of bankfull or ordinary high water flows, and trapping sediment, dams can alter the dynamics of riparian communities dramatically by decreasing opportunities for recruitment of tree species through flood scour or increasing bank erosion and loss of habitat (Johnson et al. 1976; Bradley and Smith. 1986; Rood and Mahoney 1990; Stromberg et al. 1993; Friedman et al. 1998) . Rising water levels within Olema Marsh – which was once burned annually to eliminate willows for the hunting club (Evens 1993) –currently appear to be causing a dieback of riparian vegetation along the perimeter of the marsh.

Despite elimination of riparian habitat through development, grazing, or agricultural practices, acreage of Scrub-Shrub Riparian habitat (tree canopy <66 feet in height) in the Giacomini Ranch still totaled 11 acres, while that of Forested Riparian habitat (tree canopy > 66 feet in height) totaled 17 acres, representing approximately 2 and 3 percent of this portion of the Project Area, respectively. In Olema Marsh and lower Bear Valley Creek, acreage of Forested Riparian habitat (14 acres) substantially exceeded that of Scrub-Shrub Riparian habitat (2 acres), representing 22 and 4 percent of this portion of the Project Area, respectively.

Brackish Vegetation Communities

While the extent of brackish marsh within the San Francisco Bay Estuary is considerable due to significant natural and anthropogenic freshwater sources such as the Sacramento River and wastewater treatment discharges (Baye et al. 2000), brackish marsh is not as common within central California coast's maritime systems. The central coastal marshes tend to be isolated and few because of the steep modern shoreline with few valleys or wave-sheltered environments (Baye et al. 2000). Those that do exist typically have extensive sandy substrates; relatively small, local inputs of fine sediment and freshwater discharges, and are inundated with water approaching marine salinity (34 ppt) during most of the growing season (Baye et al. 2000).

The historic extent of brackish vegetation communities was probably highest in the southern portions of Tomales Bay, as tidal influence decreased, and freshwater influences from tributaries and groundwater increased (Parsons and Allen 2004b). The combination of significant freshwater fluvial input, as well as groundwater flow along the adjacent ridges and mesas, points to southern Tomales Bay being both historically and currently a sizeable mixing zone characterized by consistently brackish to slightly saline conditions. Brackish marsh species such as bulrush (*Scirpus californicus*), cattails (*Typha* sp.), and alkali bulrush (*Scirpus maritimus*) are visible in 1942 photographs shot immediately before levee construction as patches scattered throughout what is currently the East Pasture, along Tomasini Creek, and near Railroad Point or at the base of the Tomales Bay Trail (PWA et al. 1993). To some degree, this interface "zone" of brackish water habitat probably shifted geographically on an annual basis due to interannual and long-term climatic variability, however, longer term changes in hydrologic regimes, probably on decadal scales, would be required for conversion of vegetation communities (Parsons and Allen 2004b).

In general, brackish marsh habitat within Tomales Bay has been negatively affected by construction of roads, berms, and levees that have eliminated this interface zone and created sharp demarcations between glycophytic and halophytic hydrologic regimes (Evens 1993). To some degree, this brackish hydrologic regime has endured in the Project Area despite diking, minimization of tidal flows, and augmentation of freshwater influences by irrigation, septic, etc., because of failure of the tidal control structures and a strong groundwater interaction between Lagunitas Creek and the slightly subsided Project Area (Parsons and Allen 2004b). However, a number of factors -- including possibly concentration of salts within brackish waters through evapotranspiration and agricultural-related manipulation of the land and grasses -- has managed to minimize the number and extent of “true” brackish vegetation communities relative to glycophytic and halophytic ones (Parsons and Allen 2004b).

Diked Brackish Marsh along Fish Hatchery Creek in West Pasture

Diked Brackish Marsh *(Parsons and Allen 2004b)*: Diked Brackish Marsh is dominated (>70 percent) by hydrophytic non-clover herbs that are able to tolerate water salinities that average in the brackish or mesohaline range (5-18 ppt). Diked communities are inside of levees or berms and experience typically only muted tidal action, if any. Principal tidal hydrologic sources include muted tidal flow from creeks such as Fish Hatchery and Tomasini that are managed with tidal control structures and, within non-tidal areas, interaction with a saline groundwater table. In addition, these areas are probably also heavily influenced by perennial and seasonal headwaters flooding and seep flow from Inverness Ridge and Point Reyes Mesa, etc. Diked Brackish Marsh often strongly resembles salt marsh communities, but salinities are lower due to the impounded freshwater. Diked Brackish Marsh covers a significant expanse of the very northern portion of the West Pasture, as well as some of the depressional slough traces still evident in this pasture. In the East Pasture, Diked Brackish Marsh is confined to the very northern edges of the East Pasture and around the New Duck Pond, where neither spray or flood irrigation is actively performed. This community is represented by a diverse mix of low-growing, medium-sized, and tall emergent plant species, including freshwater/brackish and saltwater species such as spearscale (*Atriplex triangularis*), pickleweed (*Salicornia virginica*), jaumea (*Jaumea carnosa*), saltgrass (*Distichls spicata*), annual beard grass (*Polypogon monspeliensis*), saltgrass (*Distichlis spicata*), perennial ryegrass (*Lolium perenne*), hydrocotyle (*Hydrocotyle ranunculoides*), bulrush, rush (*Juncus effusus*), bur-reed (*Sparganium erectum var. stoloniferum*), and cattails. Diked Brackish Marsh represents more than 6 percent of the Project Area, totaling approximately 36 acres.

Diked Brackish Marsh (Mudflat/Panne) *(Parsons and Allen 2004b)*: The lowest elevation portion of the East Pasture often floods for a significant period during the winter and spring, which results in sparsely vegetated mudflats that provide habitat for a surprising number of shorebirds and waterfowl during the rainy season. When waters evaporate, a very low-growing, sparse cover of halophytes typically develops in this Mudflat/Panne habitat, consisting of species such as sand-spurrey (*Spergularia rubra*), spearscale, and, to a much lesser extent, saltgrass. This community comprises 1.6 percent (Diked Brackish Marsh-Mudflat/Panne; 11.4 acres).

Tidal Brackish Marsh *(Parsons and Allen 2004b)*: Tidal Brackish Marsh occurs exclusively along sections of Lagunitas Creek where water salinities typically average in the brackish or mesohaline range (5-18 ppt). Tidal Brackish Marsh communities are outside of levees and berms and experience a full range of tidal and freshwater inputs. The extent of this vegetation community remains minimal within the Project Area (<1 percent or 4.8 acres) due to the fact that the Giacomini Ranch levees have infringed upon the intertidal zone where brackish marsh (and Tidal Salt Marsh-Low) would typically develop. The habitat that does exist consists of a thin fringe of either pure or mixed communities of bulrush or alkali bulrush. Occasionally, other species such as Pacific cordgrass (*Spartina foliosa*), pickleweed, or cattails are present, but only in very low numbers.

Tidal Brackish Marsh on Lagunitas Creek

Saltwater Vegetation Communities

Unlike its large neighbor to the south, the Tomales Bay estuary did not appear to have historically the extensive network of fringing salt marshes that were once present in San Francisco Bay (Parsons and Allen 2004b). U.S. Coast Survey maps from the 1860s and 1870s depict small amounts of marsh habitat along the edges of Tomales Bay, with the largest extent in the southern portion of Tomales Bay in what are currently the East Pasture, Olema Marsh, and the Bear Valley and Olema Creek floodplains (Parsons and Allen 2004b). The existing undiked marsh currently north of Giacomini Ranch appeared to be largely unvegetated or sparsely vegetated subtidal and intertidal mudflats (Parsons and Allen 2004b). Walker Creek Marsh, one of Tomales Bay's other large undiked marshes, does not even exist in the Coast Survey maps, with the marsh area shown as subtidal area and intertidal flats (Parsons and Allen 2004b).

The dramatic increase in sedimentation associated with logging and agricultural development (see more detailed discussion under Geologic Resources) had the inadvertent effect of also dramatically increasing deltaic aggradation at the mouths of creeks such as Lagunitas and Walker. Between 1860 and 2000, wetland acreage almost doubled due to this sedimentation (Parsons et al. 2004). Some of this sedimentation resulted in conversion from what appeared to be open estuarine systems with large embayments and little to no marsh habitat into salt marsh estuaries with significant marsh plain and tidal channels (Parsons et al. 2004). Deltaic marsh formed at the mouth of not only Lagunitas Creek, but also Walker Creek, which are the watershed's two largest subwatersheds and potentially the drainages with the highest sedimentation rates (Parsons et al. 2004).

While sedimentation likely increased coastal salt marsh acreage, other changes counteracted this trend, specifically construction of levees for roads and railroad bridges and "reclamation" of wetlands for agricultural purposes. For example, construction of the levee along the southern portion of Sir Francis Drake Boulevard (Levee Road) to a large degree eliminated tidal influence upstream of White House Pool. Many of the marshes on the Bay's eastern shore were impacted to some degree by construction of levees, Highway 1, and the railroad, although some have at least partially breached.

Another significant factor influencing the formation and character of Tomales Bay's salt marshes is its geology, specifically the fact that San Andreas Fault runs directly down the center of the Bay. Following the 1906 earthquake, USGS geologist G.K. Gilbert surveyed conditions in the Olema and Bolinas areas, documenting sags, trenches, landslides, and other features along the fault trace, reporting some localized losses of salt marsh (Gilbert 1908).

Structure of the deltaic marshes that developed as a result of sedimentation does not necessarily follow the classic paradigm for salt marshes, which portrays a subtle elevational gradient from "low marsh" adjacent to creeks, building gradually to a mid-marsh plain that transitions into a "high marsh" zone at the marshes' highest elevations near the upland ecotone. Wetlands at the mouth of Lagunitas and Walker creeks often support only a thin fringe of "low marsh" along the narrow intertidal creek banks that rise sharply to natural alluvial levees and then transition to broad expansive marsh plains that taper to mudflat at their bayward edge. Subtle elevational transitions between marsh plain and Bay are present more in fringing marshes along the western shore of Tomales Bay. But even in these areas, the transitional upland ecotone is often replaced by a freshwater wetland ecotone fostered by extensive groundwater influences along the perimeter of the Bay. Another noteworthy difference was the conspicuous absence in Tomales Bay for many decades of Pacific cordgrass (*Spartina foliosa*; (MacDonald 1974), although abundance of this species has surged dramatically since first being observed in the 1990s, primarily through colonization of the Lagunitas Creek delta mudflats (Parsons and Allen 2004b).

Salt Marsh Pasture *(Parsons and Allen 2004b)*: Muted tidal inflow, as well as the strong, apparent groundwater connectivity between Lagunitas Creek and the Project Area, has led to establishment of several halophytic plant communities within lower elevation portions of the pastures such as Diked Salt Marsh and Salt Marsh Pasture. Salt Marsh Pasture is characterized by a significant presence (at least 20 to 25 percent) of halophytic herbs and forbs in areas with glycophytic grasses, herbs, and pastoral species such as creeping bent grass (*Agrostis stolonifera*) or rough bluegrass (*Poa trivialis*). Halophytes or salt tolerant species include saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), pickleweed (*Salicornia virginica*), spearscale (*Atriplex triangularis*), birdfoot trefoil (*Lotus corniculatus*), etc. Salt Marsh Pasture dominated most of the northern portion of the West Pasture and some of the very northern portions of the East Pasture. In total, it represented a substantial proportion (16 percent) of the Giacomini Ranch portion of the Project Area, with 87.5 acres.

***Tidal Salt Marsh – Low, Mid, High, and High Marsh/Upland Ecotone** (Parsons and Allen 2004b)*: Tidal Salt Marsh occurs in the large expanse of undiked deltaic marsh north of the Giacomini Ranch, as well as on central bars/"islands" in Lagunitas Creek, and the fringe marsh along the outboard portion of the Lagunitas Creek levee. These salt marshes are subject to both direct tidal and freshwater influences, including headwaters flooding and high tide events. Tidal Salt Marsh-Mid accounted for approximately 4 percent of the Project Area, totaling approximately 21 acres, most of which occurs on the outboard of levees and in the undiked marsh north of Giacomini Ranch.

Tidal Salt Marsh-Mid and Tidal Salt Marsh-High in undiked marsh north of Giacomini Ranch

Deltaic and fringe marshes typically support a thin fringe of low marsh along the banks of tidal marsh channels and creeks characterized by species such as Pacific cordgrass, alkali bulrush (*Scirpus maritimus*), and pickleweed. The alluvial levees running along larger creeks such as Lagunitas support a "high marsh/upland ecotone" vegetation community with species such high marsh species such as saltgrass, alkali heath, and gumplant (*Grindelia* sp.) mixed with upland species such as red fescue (*Festuca rubra*).

Inland of these alluvial levees lie broad, expansive marsh plains supporting interspersed pockets of very low-growing mid-marsh and high-marsh species assemblages, as well as small, typically unvegetated marsh ponds. Mid- and lower elevation high-marsh zones are dominated by jaumea, saltgrass, seaside arrow-grass (*Trigochlin maritima*), arrow-grass (*Triglochin concinna*), and western marsh rosemary (*Limonium californicum*). During the summer, the presence of purple-flowered western marsh rosemary easily distinguishes lower-elevation high marsh in deltaic marshes. Alluvial fan-tidal ecotones support distinctive local plant assemblages, including uncommon and rare species such as Humboldt Bay owl's-clover (*Castilleja ambigua* ssp. *humboldtiensis*; FSC), Point Reyes bird's beak (*Cordylanthus maritimus* ssp. *palustris*; FSC), and, to a much lesser extent, Marin knotweed (*Polygonum marinense*; FSC; Baye et al. 2000; Parsons 2003). These species are discussed in greater detail later in this section.

Other

The Project Area also includes a number of other habitats not directly classifiable by specific hydrologic regimes. Many of these are upland communities and/or represent a minor component within the Project Area.

Coastal Mesic Scrub on Point Reyes Mesa Bluff

***Mesic Coastal Scrub** (Parsons and Allen 2004b)*: Even some of the limited coastal scrub habitat present in the Project Area incorporates a mesic or moist component, with perennial or seasonal seep flow on the Point Reyes Mesa creating a unique vegetation community characterized by both arroyo willow (*Salix lasiolepis*) and coyote brush (*Baccharis pilularis*). In general, this community is dominated by a dense canopy of low shrubs or trees, but with scattered grassy or ruderal openings. Willow grows in combination with coyote brush, poison hemlock (*Conium maculatum*), poison oak (*Toxicodendron diversilobum*), and even coast live oak (*Quercus agrifolia*). Natural seep influences may be augmented to some degree by septic systems from residential areas on Point Reyes Mesa. Groundwater influences appear to extend beyond the slope to Tomasini Creek, which has been bermed to contain flow along the base of Point Reyes Mesa. Acreage of Mesic Coastal Scrub was relatively high because it spans the face of the Point Reyes Mesa, totaling 12.4 acres or 2 percent of the Project Area.

Ruderal (*Parsons and Allen 2004b*): Ruderal communities represented a significant portion of the Project Area. Ruderal included areas supporting a mixture of herbs and forbs with often no clear or consistent dominance pattern. Most of the levees and berms within the Project Area, as well as the alluvial floodplain of Fish Hatchery Creek in the West Pasture, were mapped as Ruderal. A large proportion of the species within these polygons was non-native, but a significant amount of blue wildrye was also observed growing on the levees. Hydrologic input to these communities consists of very infrequent overbank flooding and precipitation. Acreage totaled 54.5 acres or approximately 9 percent of the Project Area.

Vegetation Communities of Special Significance – Wetlands and Riparian Areas

While wetlands are included as vegetation resources, wetlands really represent a complex integration of geologic, hydrologic, and biological processes. Wetlands are probably often described as vegetation communities, probably because the unique vegetation that typically occurs in wetlands is the perhaps the most enduring and easily identifiable characteristic of these complex systems. However, it is the integration of these geologic, hydrologic, and biological processes that enables wetlands to provide the diverse number of hydrologic, ecological, and socioeconomic functions and "services" to wildlife and humans that they do. Some of the functions and services that wetlands provide – and that the proposed project is trying to restore – include water quality improvement, floodwater retention, and habitat for resident and non-resident wildlife. While other "vegetation communities" such as forests and grasslands obviously have intrinsic value, in terms of the number and degree of functions and services, wetlands and riparian habitats arguably offer the greatest benefit to the biological and social environment.

The beauty of California's relatively rugged coastline has encouraged extensive residential, commercial, and agricultural development, dramatically reducing acreage of coastal wetlands, particularly in southern and central California. Estimates for coastal wetland loss are as high as 95 percent. Despite these losses, California supports the most extensive coastal wetlands of any west coast state except Alaska (NOAA 1990). Total wetland acreage has been estimated at 3,800 acres for the outer central California coast stretching from Cape Mendocino in the north to Point Conception in the south, excluding San Francisco Bay (Dennis and Marcus 1984). Recent estimates of wetland acreage within Tomales Bay totaled 944.2 acres (Parsons et al. 2004), with Giacomini Ranch and Olema Marsh combined accounting for approximately 613 acres. Together, the Project Area wetlands represent approximately 16 percent of the remaining wetlands present along the outer central California coast.

The beauty of California's relatively rugged coastline has encouraged extensive residential, commercial, and agricultural development, dramatically reducing acreage of coastal wetlands, particularly in southern and central California.

Regulatory and Policy Setting

The increasing awareness of the value and importance of wetland and riparian functions for both people and wildlife may represent one of the primary reasons that impacts to wetlands and their watersheds have become more closely regulated in recent decades. The U.S. Army Corps of Engineers (Corps) oversees Section 404 of the federal Clean Water Act and Section 10 of the federal Rivers and Harbors Act, both of which serve to ensure that impacts to navigable waters and special aquatic sites such as wetlands are minimized. In addition, wetlands are also regulated under other federal statutes, including Section 401 of the Clean Water Act and the federal Coastal Act, both of which are administered by state agencies – RWQCB and California Coastal Commission (CCC), respectively.

The Park Service also scrutinizes projects with the potential to impact wetlands in order to comply with an Executive Order that decrees that federal agencies should "...avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct and indirect support of new construction in wetlands wherever there is a practicable alternative…" In compliance with this Executive Order, the Park Service adopted a policy of "no net loss of wetlands," with a longer term goal of net gain Service-wide. Implementation of this policy meant that, for new development or new activities, the Park Service pledged to avoid adverse wetland impacts to the extent practicable; minimize impacts that could not be avoided, and compensate for remaining unavoidable adverse impacts through restoration of degraded wetlands at a 1:1 ratio. Unlike Section 404 of the Clean Water Act, adverse impacts under Executive Order 11990 are not interpreted strictly as discharge of dredged or fill material, but encompass a much broader range of actions, including groundwater withdrawals, water diversions, nutrient enrichment, livestock grazing, pumping, flooding, and impounding.

These regulations and policies have seemingly increased the amount of confusion regarding how wetlands are defined. The confusion stems from the fact that jurisdiction or the amount and type of wetlands regulated under these statutes can vary between administrative agencies. While the RWQCB relies largely upon the Corps and its 1987 methodology to determine Section 401 jurisdiction, the CCC has taken a broader, more expansive interpretation of wetlands, and so has the Park Service. The net result is that there could be substantially more CCC- and Park Service- regulated wetlands than Corps-regulated wetlands within the same Project Area.

Riparian zones often fall into one of these regulatory "gray" zones. Riparian zones can be defined as "wetlands" by the Corps if they remain wet enough to support hydrophytic or "water-loving" plant species and have soils that show indications of prolonged ponding or saturation. Typically, juvenile or young riparian stands often qualify as Corps' "wetlands" and then transition to non-jurisdictional wetlands as the elevation becomes higher through sediment deposition, and older plants become more capable of surviving through tapping into groundwater tables rather than relying on surface inundation or saturation. The CCC, however, might continue to classify them as wetlands based exclusively on the predominance of hydrophytic or water-loving plant species. Ultimately, these disparities in regulatory interpretation really reflect differences in the jurisdiction of these various state and federal agencies, not differences in the biological or ecological definition of wetlands.

Within the Project Area, the disparity between these jurisdictional boundaries was not substantial, probably due to the fact that, despite diking and its appearance as largely a grassy pasture, most of the Giacomini Ranch has remained "wetland" from a regulatory perspective. Generally, only the highest or most topographically elevated portions of the Ranch would be considered "upland," and, occasionally, even some of those areas were delineated as wetland due to the influence of seeps. For the purposes of complying with different federal, state, and local regulations and policies governing actions in wetlands, three wetland delineations using different delineation protocols were performed to determine areas subject to the jurisdiction or oversight of the Corps, RWQCB, CCC, CDFG, Park Service, and County and local agencies and organizations. The results of these delineations are described below.

Hydrogeomorphic Classification

Within the wetland regulatory and management community, there has been a strong push in recent years to classify wetlands not only according to vegetation type and structure such as freshwater marsh or salt marsh, but on hydrogeomorphology. Naturally, regional variations exist in the specific types of hydrogeomorphic features present, but most wetlands share some basic hydrologic and geomorphic attributes that enable them to be classified, on at least a basic level, by a methodology developed by Brinson (1993). The Project Area incorporates at least five different hydrogeomorphic classes of wetlands, including Estuarine Fringe; Slope Wetlands; Groundwater Slope Wetlands; Riverine Wetlands; and Organic Soil Flats. Because of the hydrologic complexity within the Project Area, a considerable amount of overlap occurs between these geomorphic classes.

Estuarine Fringe Wetlands are comprised of tidal wetlands in the undiked marsh north of the Giacomini Ranch, as well as the narrow fringe of undiked marsh on the outboard of the Giacomini Ranch levees and some of the islands or topographically elevated "central bars" in the middle of Lagunitas Creek. The entire Project Area could be classified as Riverine Wetlands, which include floodplains and riparian areas along rivers, creeks, and streams, although a large portion of the Riverine Wetlands for Lagunitas Creek and Tomasini Creek have been eliminated or minimized through levees that greatly reduce the amount of overbank flooding. Only Fish Hatchery Creek, Bear Valley Creek, and some of the small drainages flowing off the Inverness Ridge are hydrologically connected with their floodplains, although hydrologic functioning of these creeks has also been negatively impacted by culverts, road levees, ditching, and frequent dredging.

With levees reducing the amount of overbank flooding, most of the Giacomini Ranch could be classified as functioning more as Slope Wetlands, with surface runoff and precipitation generally sheetflowing from the higher-elevation southern portions of the two pastures towards the lower-elevation northern portions, where waters drain out either through one-way or modified one-way tidegates or over concrete spillways. Some of the surface run-off derives from groundwater that emerges at the base of the Inverness Ridge or Point Reyes Mesa and flows into the two pastures. This abundant groundwater creates groundwater slope wetlands or, as they have been referred to in other areas of the country, "seepage toeslope" wetlands on the perimeter of both the West and East Pastures. In the West Pasture, the western perimeter is at a higher elevation than most of the rest of the pasture, encouraging sheetflow of this emergent groundwater into the center of the pasture, except where there are depressional basins such as in the extensive freshwater marsh along Sir Francis Drake Boulevard. The Point Reyes Mesa appears to support both seepage toeslope wetlands, as well as localized areas of hillside seepage slope wetlands, which manifest themselves as extensive arroyo willow forests or Mesic Coastal Scrub on the face of the Point Reyes Mesa bluff. In the East Pasture, the influence of these seeps creates more localized seepage toeslope features, because the perimeter elevation is flatter and more consistent with elevations in the center of the pasture.

Corps Jurisdiction

The Corps regulates several types of activities in waters of the United States, which includes navigable waters, tributaries to navigable waters, special aquatic sites (e.g., wetlands), and areas that are "adjacent" to navigable waters. These waters are regulated under Section 404 of the Clean Water Act (40 CFR Section 328.3) or Section 10 of the Rivers and Harbors Act (33 U.S.C. 403). A wetland delineation was performed by the Seashore and verified by the Corps in 2005 (Parsons 2005). A description of delineated wetlands is provided below, and acreages are provided in Table 11 (Parsons 2005). Based on this delineation, 536.6 acres of wetlands and waters subject to Section 404 jurisdiction under the Clean Water Act exist in the Project Area, with 249.3 of those acres also subject to Section 10 jurisdiction under the Rivers and Harbors Act (Figure 32; Parsons 2005)

***Section 404 Jurisdictional Waters* (Parsons 2005).** Within the Project Area, jurisdictional tidal features were defined as wetlands and waters that fell below the High Tide Line (HTL), which was calculated as 8.06 ft NAVD88 (Figure 32). Jurisdictional tidal waters present in the Delineation Study Area consisted of unvegetated (<5 percent vegetation cover) areas below the High Tide Line (HTL) in Lagunitas Creek and the downstream portions of Tomasini, Fish Hatchery, Bear Valley, and Olema Creeks. Jurisdictional non-tidal waters consisted of unvegetated areas below the Ordinary High Water (OHW) elevation. Non-Tidal Waters were mapped in small portions of Fish Hatchery Creek, Tomasini Creek, 1906 drainage, and a small drainage near White House Pool. Potential jurisdictional Section 404 "adjacent" waters consisted of one small portion of a historic slough in the Giacomini Ranch East Pasture that has been hydrologically disconnected from Tomales Bay by the Lagunitas Creek levee.

***Section 404 Jurisdictional Wetlands* (Parsons 2005).** Jurisdictional tidal wetlands were comprised of vegetated areas (>5 percent vegetation cover) below the HTL (Figure 32). Within the Project Area, tidal wetlands included the undiked marsh plain north of the Giacomini Ranch, fringing marsh along Lagunitas Creek, and fringing marsh along the downstream portions of Tomasini Creek and the Silver Hills drainage outlet. It also included diked portions of Fish Hatchery Creek in the northern portion of the West Pasture that are flooded during high tides. Jurisdictional Non-Tidal Wetlands consisted of vegetated areas (vegetation cover > 5 percent) below the OHW. Within the Project Area, Non-Tidal Wetlands included vegetated, upstream portions of Fish Hatchery Creek, the Old Slough in the Giacomini Ranch West Pasture, and Tomasini Creek. It also included most of Silver Hills drainage channel that flows parallel to Levee Road and is then culverted to flow through the White House Pool County Park. By far, the largest portion of Non-Tidal Wetlands occurred in Olema Marsh, which largely falls below OHW and is heavily vegetated.

FIGURE 32. CORPS JURISDICTIONAL WETLANDS AND WATERS

Jurisdictional Section 404 “adjacent” wetlands represented most of the jurisdictional features delineated in the Project Area. “Adjacent” wetlands consisted of vegetated areas directly adjacent to Tidal and Non-Tidal Waters and Wetlands that could be considered connected either through hydrology (e.g., groundwater movement) or ecologically (e.g., movement of organisms). Specifically, these jurisdictional features included most of the wetlands in the Giacomini Ranch pasturelands and selected areas in Olema Creek and in County Park lands near White House Pool and the Green Bridge/dairy facility area.

***Section 10 Jurisdictional Waters* (Parsons 2005).** Jurisdictional Section 10 waters consisted of navigable waters either presently or historically subject to tidal influence that fall below Mean High Water (MHW; Table 11; Figure 32). In the Project Area, jurisdictional Section 10 waters included Lagunitas, Tomasini, Fish Hatchery, Bear Valley, and Olema Creeks. In addition, it included portions of the Giacomini Ranch, Olema Marsh, and Olema Creek floodplains that were historically subtidal or intertidal and therefore below MHW before being diked or culverted/bridged.

TABLE 11. ACREAGES OF JURISDICTIONAL SECTION 404 WETLANDS AND WATERS AND SECTION 10 WATERS

	Section 404 Waters			Section 404 Wetlands			Section 10
	Tidal	Non-Tidal	Adjacent	Tidal	Non-Tidal	Adjacent	Waters
Project Area	43.88	0.36	1.93	54.99	49.85	385.63	249.28

Source: Parsons 2005

CCC Jurisdiction

Within California, the CCC administers the state program (California Coastal Act) for implementation of the federal Coastal Zone Management Act (CZMA). Any action by a federal agency such as the NPS requires a federal consistency determination by the CCC as required by CZMA. The CCC reviews all proposed wetland development projects within the California Coastal Zone. The Project Area falls within the Coastal Zone.

In the Coastal Zone, the CCC, with assistance from CDFG, is responsible for determining the presence and size of wetlands subject to regulation under the California Coastal Act (1976). The CCC has adopted the CDFG wetland definition and classification system, which is a modified version of the Cowardin classification system (Cowardin et al. 1979) in which an area needs only to meet one of the three parameters (hydrophytic vegetation, hydric soils or wetland hydrology) to qualify as a wetland (Radovich 1993). The Cowardin classification system is also the basis for the National Wetland Inventory (NWI) maps of wetlands and waters prepared by the USFWS for the entire United States. Because NWI is prepared from high-altitude aerial photography, mapped wetlands are typically those that are readily discernible in aerial photographs, such as perennially ponded marshes, stock ponds, lakes, and forested riparian areas along streams and drainages. It is less likely to incorporate seasonal or saturated wetlands that pond only seasonally or are primarily saturated through the growing season and support a low-growing emergent vegetation cover that is indistinct in aerial photographs from adjacent grasslands (e.g., wet meadows, flats, seeps, etc.)

Because hydrophytic vegetation is prevalent within the Seashore and coastal Marin County, the CCC wetland delineation was conducted as part of the vegetation mapping and Cowardin wetland classification effort that create and classified polygons with similar vegetation communities or plant associations (Parsons 2005). For this reason, areas that supported hydrophytic vegetation, but did not necessarily appear to have wetland hydrology, are incorporated into the CCC wetlands map, but are absent from the map of wetlands potentially subject to jurisdiction by the Corps (Parsons 2005) or management and oversight by the Park Service.

This delineation method yielded vastly different results than both the 1991 NWI map and Corps map. The 1991 NWI map identified only 17 wetland and aquatic habitat types in the Project Area, while approximately 225 different classifications of aquatic habitat were mapped by the Seashore (Parsons 2005). Based on the delineation, approximately 90 percent or 673.1 acres of the total Project Area qualified as a wetland potentially subject to CCC oversight (Figure 33; Parsons 2005). The Giacomini Ranch, adjacent undiked marsh, and County of Marin park areas near White House Pool and the Green Bridge account for 593.4 acres, with Olema Marsh and the downstream portion of Bear Valley Creek (79.7 acres) comprise the remainder.

Because the CCC takes a broader interpretation of wetlands relative to its regulatory oversight, acreages of wetlands potentially subject to CCC jurisdiction are greater than that subject to Corps' jurisdiction. A substantial amount of these "drier" areas that did not qualify as Corps jurisdictional wetlands were riparian areas designated as wetland under the USFWS's new Riparian System code (see below for more detail). Table 12 presents an abbreviated list of the type and acreages of wetlands delineated within the Project Area that would appear to be potentially subject to oversight by the CCC. Below is a brief description of the Cowardin system and classes that were mapped within the Project Area.

***System/Subsytems* (Parsons 2005).** Because of its location at a major freshwater-estuarine confluence, the Project Area is a combination of palustrine (freshwater) and estuarine (saltwater) wetlands and Riparian non-wetlands. Estuarine Systems are those in which salinities during the period of average annual low flow exceeds 0.5 ppt (Cowardin et al. 1979). Areas mapped as Estuarine included not only undiked, tidal areas such as Lagunitas Creek and the undiked marsh north of Giacomini Ranch and Lagunitas Creek, but even some areas inside dikes such as the Giacomini Ranch West and East Pastures, Tomasini and Fish Hatchery Creeks, and Olema Marsh. Acreage of Estuarine Systems within the Project Area totaled 332.94 acres, with almost all of that area occurring in the Giacomini Ranch and adjacent areas (332.89 acres; Table 12). Estuarine influence in these areas results either from tidal surface flow muted to some degree either naturally or by improperly functioning tidegates (Olema Marsh; Fish Hatchery Creek/northern portion of Giacomini Ranch West Pasture; Tomasini Creek) or from indirect tidal interaction with the saline groundwater table. The elevated salinities observed in the diked pastures' groundwater tables probably derive from residual marine salts deposited in underlying estuarine sediments when these areas were open to tidal flushing (KHE 2006a). Most of the mapped Estuarine areas consisted of the Intertidal Subsystem (2), but the Subtidal Subsystem (1) did occur in Lagunitas Creek, the northern portions of Fish Hatchery and Tomasini Creeks, and some diked portions of old sloughs in the Giacomini Ranch.

Because of the extensive tidal influence at the northern end of the Project Area, Palustrine Systems dominate the southern end, particularly Olema Marsh, Bear Valley Creek, and the southern end of the Giacomini pastures. In the northern end of the Project Area, Palustrine areas are relegated to the fringes of the Giacomini Ranch on higher gradient sections of creeks such as Tomasini and Fish Hatchery and small drainages and higher elevation areas adjacent to seeps flowing off the Inverness Ridge or Point Reyes Mesa. Acreage of Palustrine Systems within the Project Area totaled 366.6 acres, with 300.9 of those acres occurring in the Giacomini Ranch (Table 12). Often a sharp juxtaposition exists between Palustrine and Estuarine wetlands, as evidenced by the West Pasture freshwater marsh or Palustrine Emergent marsh polygon (e.g., PEM1Eb) adjacent to Sir Francis Drake Boulevard that is bordered by an Estuarine Emergent (E2EM1R) Diked Tidal Salt Marsh polygon with summer groundwater salinities as high as 50 ppt. There are no Palustrine Subsystems.

Some areas on the upland perimeter of the Project Area were mapped as the NWI's new Riparian (Rp) System category. Riparian (Rp) Systems support Scrub Shrub or Forested Class hydrophytic vegetation, but lack wetland hydrology. Acreage of Riparian Systems within the Project Area totaled 55.1 acres, with 37.9 of those acres occurring in the Giacomini Ranch (Table 12). Most areas within the Project Area that qualified as Riparian (Rp) are Intermittently (J) or Temporarily Flooded (A) in which flooding occurs only at peak storm flow discharge or for several days following peak discharge or flooding occurs only an episodic basis (i.e., recurrence interval > 2 years). These Riparian Systems are dominated by deeply rooted riparian tree and shrub species -- many of which are considered hydrophytic at least in their seedling and juvenile stages -- that typically rely on groundwater tables that are greater than 12 inches from the soil surface. All of the Riparian System areas were mapped as Lotic (1) or flowing water Subsystems, because they occurred at the periphery of freshwater streams, creeks, drainages, or actively flowing seeps.

FIGURE 33. WETLANDS POTENTIALLY SUBJECT TO CCC OVERSIGHT

TABLE 12. ACREAGES OF COWARDIN SYSTEMS AND CLASSES IN THE GIACOMINI WETLAND RESTORATION PROJECT DELINEATION STUDY AREA

Wetland Code	Classification	Giacomini Ranch & SLC and County Park Lands (Acres)	Olema Marsh and Bear Valley Creek (Acres)	Delineation Study Area Total (Acres)
SYSTEM				
E	Estuarine	332.89	0.05	332.94
P	Palustrine	300.87	65.72	366.59
Rp	Riparian	37.92	17.21	55.13
CLASS				
UB	Unconsolidated Bottom	52.49	5.60	58.09
AB	Aquatic Bed	9.86	4.03	13.89
EM	Emergent	523.61	36.07	559.68
SS	Scrub Shrub	30.62	5.25	35.87
FO	Forested	54.51	32.04	86.55

Class/Subclass. Most of the Project Area is dominated by low-growing Emergent (EM), Persistent (1) plant species such as pastoral, salt marsh, and ruderal forbs and herbs. Acreage of Emergent Class within the Project Area totaled 559.7 acres, 523.6 acres of which occur in the Giacomini Ranch and adjacent areas (Table 12). Areas with taller vegetation (Scrub Shrub or Forested) tended to occur outside the Giacomini Ranch or on its perimeter due the lack of grazing and/or higher quantities of freshwater from seeps and drainages and creeks. Acreage of Scrub Shrub Class in the Project Area totaled 35.9 acres, with 30.6 of those acres occurring on the perimeter of the Giacomini Ranch or adjacent areas (Table 12). As with Aquatic Bed, the areal extent of the Scrub Shrub class was relatively low within all regions of the Project Area. Acreage of the Forested Class totaled 86.6 acres, with 54.5 acres occurring on the perimeter of the Giacomini Ranch and adjacent areas (Table 12). The Forested Class was the dominant class in the portion of Bear Valley Creek (20.6 acres) within the Project Area and the second highest class in the White House Pool and Green Bridge County Park (54.5) and Olema Marsh (11.4 acres) areas (Table 12). Unconsolidated Bottom subclasses within the Project Area consisted largely of Cobble-Gravel (1), Sand (2), Mud (3), and Organic (4). Mineral soils (Subclasses 1-3) dominated most of the Project Area, but a combination of Organic and Mud sediments occurred in some of the unvegetated portions of Olema Marsh.

Park Service Oversight

Director's Order #77-1 established Park Service policies, requirements, and standards for implementing Executive Order 11990, which directs federal agencies to avoid long- and short-term impacts to wetlands. The Park Service uses the Cowardin classification system (Cowardin et al. 1979) as the basis for creating a Park Service standard for defining, classifying, and inventorying wetlands that might be subject to adverse impacts and Park Service oversight.

Park Service lands within the Delineation Study Area generally include the Giacomini Ranch and portions of Bear Valley Creek upstream of Bear Valley Road and the southern 14.0 acres of Olema Marsh. Wetlands potentially subject to management and oversight by the Park Service were delineated using the Cowardin wetland delineation definition developed by the USFWS (Parsons 2005). This definition relies on the presence of two of three criteria – wetland hydrology and hydrophytic vegetation or hydric soils – to classify areas as wetlands. Because of the similarity of this approach to that of the Corps, the Seashore proposed to delineate these wetlands by modifying, if necessary, the boundary line proposed for potential Corps' jurisdiction to incorporate areas that met two, but not necessarily all three, criteria (Parsons 2005).

After reviewing information collected during the delineation, there did not appear to be any areas that would require expansion of the Corps' potential jurisdictional boundary (Parsons 2005). There were some areas that technically only met two of the criteria, but most of these areas qualified as Corps' wetlands, as well, because wetland hydrology and hydrophytic vegetation were present, and the absence of hydric soil indicators could be explained by the fact that soils were fill, recently disturbed, or alluvial and therefore less likely to display obvious hydric soil indicators. Therefore, wetlands potentially subject to management and oversight by the Park Service in the Project Area total 446.4 acres.

CDFG

CDFG has historically had a more limited jurisdiction than the Corps, focusing specifically on lakes, major tidal sloughs, rivers, and streams, where streams are defined as "....a body of water that flows at least periodically or intermittently through a bed or channel having banks...." Jurisdiction is typically defined as the bed of the drainage and the bank up to the top of significant cut. CDFG jurisdiction over riparian habitat is discussed in the next section.

CDFG jurisdiction in the Project Area would include only non-federal lands, specifically portions of Lagunitas Creek owned by the State Lands Commission, Wildlife Conservation Board, or privately owned; Fish Hatchery Creek directly upstream and downstream of the Giacomini Ranch; 1906 Drainage directly upstream of the Giacomini Ranch; the northern portion of Bear Valley Creek and Olema Marsh, and the portion of Tomasini Creek upstream of Mesa Road (Figure 34). CDFG jurisdiction on Lagunitas Creek is somewhat complicated, because, in the southern portion, it would extend to top of bank on the southern bank of the creek, where lands are privately owned or owned by the Wildlife Conservation Board. On the northern bank, which is the Park Service-owned Giacomini Ranch, it would extend to the Ordinary Low Water mark, which is the ownership boundary for State Lands Commission. From White House Pool, CDFG would have jurisdiction over Lagunitas Creek below the OLW mark, because both banks of the creek are owned by the Park Service. CDFG jurisdiction on private lands is not shown. Acreage of potential CDFG jurisdiction over streams, rivers, lakes, and major sloughs in the Project Area totals 73.6 acres (Figure 34).

Riparian Buffers and Protection Ordinances

While riparian areas are often protected through federal regulations and policies as "wetlands," riparian areas have received some special protection of their own through state and local regulations and ordinances.

- ***CDFG***. In addition to streams, rivers, and lakes, CDFG also typically includes adjacent riparian areas within its jurisdiction. Jurisdiction is typically defined as extending to the outer limits of riparian vegetation where it occurs beyond the bank cut. CDFG jurisdiction in the Project Area would include only non-federal lands, specifically portions of Lagunitas Creek owned by the State Lands Commission, Wildlife Conservation Board, or privately owned; Fish Hatchery Creek directly upstream and downstream of the Giacomini Ranch; 1906 Drainage directly upstream of the Giacomini Ranch; the northern portion of Bear Valley Creek and Olema Marsh, and the portion of Tomasini Creek upstream of Mesa Road (Table 13; Figure 34). Acreage of potential CDFG jurisdiction over riparian habitat in the Project Area totals 24.7 acres (Figure 34).

- ***Coastal Zone***. Marin County has enacted a Streamside Conservation Area (Marin County Code, Title 22, Section 22.56-G(3), however, within the Coastal Zone, the SCA is defined by the Local Coastal Plan. Buffers in the Coastal Zone are defined to include all riparian vegetation on both sides of the stream AND the area 50 feet landward from the edge of the riparian vegetation (Marin County Comprehensive Planning Department 1981). In no case shall the stream buffer be less than 100 feet in width, from either side of the stream, as measured from the top of the stream bank. No development or vegetation removal is permitted within this buffer unless no alternative sites are feasible. LCP jurisdiction would include both federal and non-federal lands and would therefore incorporate riparian vegetation or "zones" on Lagunitas Creek, Fish Hatchery Creek, 1906 Drainage, Bear Valley Creek, Tomasini Creek, and several other small drainages feeding into the Giacomini Ranch, Lagunitas Creek, and Olema Marsh (Table 13; Figure 34). Acreage of potential LCP jurisdiction over riparian habitat in the Project Area totals 84.9 acres (Figure 34).

FIGURE 34. RIPARIAN AND BUFFER HABITAT

Other Buffers and Protection Ordinances

Local policies have established protection ordinances for other types of buffers.

- ***Point Reyes Mesa Bluff***: In addition, the LCP (Marin County Comprehensive Planning Department 1981) and the Point Reyes Station Community Plan (Marin County Community Development Agency 2001) have developed some specific protection objectives regarding the Point Reyes Mesa bluff, including, as was stated in the Community Plan (Marin County Community Development Agency 2001), "preservation of the physical, ecological, and visual integrity of the bluff area located above the old railroad right-of-way through the development review process establishment of a 100-foot buffer zone extended eastward from the eastern edge of the railroad grade." Based on the LCP and Community Plan, approximately 17.0 acres at the base of the Point Reyes Mesa Bluff extending from Mesa Road to Railroad Point or the terminus of the Tomales Bay Trail would be subject to oversight under the LCP and Point Reyes Station Community Plan in the Project Area (Table 13; Figure 34). In many areas, the Bluff would also qualify as Corps and CCC jurisdictional wetland and/or riparian habitat subject to oversight by CDFG and the LCP.

- ***Upland Buffer- Wetlands: Coastal Zone***. The Local Coastal Plan has developed policies for protecting upland areas on the perimeter of wetlands. An upland buffer for wetlands at least 100 feet in width minimum has been established on the periphery of wetlands in the Coastal Zone. No development or vegetation removal is permitted within this buffer unless it complies with LCP policies. LCP jurisdiction would include both federal and non-federal lands and would therefore incorporate upland areas in the Project Area in and on the perimeter of the Giacomini Ranch and Olema Marsh. Acreage of potential LCP jurisdiction over upland habitat in the Project Area totals 81.9 acres (Table 13).

TABLE 13. ACREAGE OF RIPARIAN, BLUFF, AND OTHER HABITAT POTENTIALLY SUBJECT TO REGULATION OR OVERSIGHT

	CDFG – Riparian	*LCP – Riparian Buffer*	*LCP and Community Plan – Bluff Buffer*	*LCP – Upland Buffer*
Habitat potentially subject to jurisdiction or oversight	*24.7 acres*	*84.9 acres*	*17.0 acres*	*81.9 acres*

Wetland and Riparian Condition and Functionality

In order to achieve protection of these ecosystems, the Park Service has been directed to "conduct or obtain parkwide wetland inventories to help ensure proper planning with respect to the management and protection of wetland resources" (NPS 2006, Section 4.6.5).

Beginning in 2000, the Seashore initiated an enhanced wetlands mapping project. During the first two phases of the project, more than 911 acres within 230 wetlands polygons or areas were inventoried and mapped. In 2003, the Seashore began a third phase of the wetlands mapping project that focused on the 140,094-acre Tomales Bay watershed. As one of the larger landowners within the Tomales Bay watershed, the Park Service felt that it could contribute to improving water quality within Tomales Bay by identifying potential pollutant sources on its lands and targeting degraded wetlands for restoration (Parsons et al. 2004). In order to evaluate the condition of existing wetlands and how well they are currently functioning, the Seashore recognized that it needed to expand its mapping efforts to incorporate a condition and functional assessment of wetlands. A number of different methodologies exist for assessing wetland condition and/or functions, but, ultimately, the Seashore created a hybrid assessment methodology that incorporated components from several methodologies, including the recently developed California Rapid Assessment Methodology (CRAM; (Collins et al. 2003; 2004). This assessment methodology uses indicators or metrics of wetland condition or functionality based on observable impairments or disturbances to hydrologic processes, hydrologic functions, landscape connectivity, soils, vegetation communities, and ecological functions such as wildlife habitat, as well as qualitatively ranking the number and intensity of potential “stressors” to wetlands such as grazing, contamination, etc. (Parsons et al. 2004).

As part of this functional assessment, more than 1,500 acres and 717 polygons of wetlands were mapped within the western portion of Tomales Bay and Olema Valley (Parsons et al. 2004). Using a semi-quantitative evaluation of scores for both functionality and stressors, sites were ranked as being either high or medium priority for more detailed future evaluation of condition and functionality and possible future restoration. A large percentage of the sites or Functional Units that were considered either high or medium priority for restoration occurred in specific areas of the watershed, including the Waldo Giacomini Ranch in the southern portion of Tomales Bay and the Bear Valley Creek subwatershed (Parsons et al. 2004). In fact, of the six high priority restoration “sites” or drainage areas identified in the Tomales Bay-Olema Valley watershed, three of them were on the Giacomini Ranch, specifically the eastern portions of the East Pasture-Tomasini Creek, the leveed portion of Lagunitas Creek, and the diked northern portions of the East and West Pasture (Parsons et al. 2004).

While functional assessment is still to some degree in its infancy as a tool for characterizing the condition and functionality of wetlands, the Seashore believes that this approach could be very promising in terms of the type of information that it can provide for the resource managers (Parsons et al. 2004). Incorporation of condition and functional assessment could substantially increase the value of the wetland inventory efforts that the Seashore has been conducting since 2000. In addition, this approach will provide a framework for either selection or justification of additional areas selected for source reduction and restoration efforts.

Vegetation Communities of Special Significance – CNDDB Natural Communities

In addition to special status plants, the California Natural Diversity Database (CNDDB) also tracks occurrences of rare and significant vegetation communities that have been imperiled by commercial and residential development, invasion by non-native species, etc. (CDFG 2005). These special habitats or Natural Communities have been described using a vegetation classification system initially developed by Holland (1986) specifically to create a uniform system for classifying communities in which sensitive plant and animal species are found for the CNDDB. CDFG is in the process of transitioning its classification of Natural Communities from the Holland (1986) system to one developed by Sawyer and Keeler-Wolf (1995). Natural Communities are the cornerstone of CDFG’s broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity, termed Natural Communities Conservation Planning Program or Habitat Conservation Plans (CDFG 2006). The NCCP began in 1991 with large-scale planning efforts for more than 6,000 square miles of coastal sage scrub habitat that supports the California gnatcatcher and approximately 100 potentially threatened and endangered species (CDFG 2006).

Two special habitats or Natural Communities have potential to occur within the vicinity of the Project Area: Coastal and Valley Freshwater Marsh and Northern Coastal Salt Marsh (CDFG 2005). Coastal Freshwater Marshes are permanently flooded freshwater wetlands with deep, peaty soils dominated by perennial, emergent monocots approximately 4-5 m tall such as rush (*Scirpus* spp.) and cattails (*Typha* spp.; Holland 1986). It has been documented from a 34-acre marsh west of Drakes Beach (NDDB 2005). Northern Coastal Salt Marsh is characterized by salt-tolerant halophytes that form moderate to dense cover approximately 1 m tall and is usually separated into “zones” based on tidal elevation – low marsh, mid marsh, and high marsh (Holland 1986). Northern Coastal Salt Marsh is documented from the head of Tomales Bay (CDFG 2005).

Of the vegetation communities mapped within the Project Area, at least four potentially qualify as a CNDDB special habitat or Natural Community: Tidal Salt Marsh-Low, Tidal Salt Marsh-Mid, Tidal Salt Marsh-High, and High Marsh/Upland Ecotone. These communities appear to match the Northern Coastal Salt Marsh habitat described by Holland (1986) and subsequently identified as a special habitat. As noted earlier, Northern Coastal Salt Marsh has already been documented at the head of Tomales Bay. While information on the exact location of this occurrence was not available, it is likely that the CNDDB record refers to the undiked marsh north of the Giacomini Ranch and possibly at the base of the Tomales Bay trailhead. However, this occurrence should be expanded to include the fringe on the outboard portion of the Lagunitas Creek and Giacomini Ranch levees, as well, particularly the northern portions of the levee where the “shelf” is widest.

Most of the freshwater marshes mapped within the Giacomini Ranch do not appear to qualify as a CNDDB special habitat, even the somewhat floristically unique Freshwater Marsh in the West Pasture. According to Holland

(1986), Coastal and Valley Freshwater Marshes are characterized by being permanently flooded by freshwater rather than brackish or alkaline waters or waters having variable salinity regimes. Probably because of the historical tidal incursion through the malfunctioning one-way tidegate on Fish Hatchery Creek, this marsh appears to have a highly variable salinity regime, with salinities increasing during the summer and dropping during the winter and spring when seep flows are probably highest. The high spatial (and temporal) variation in salinity within this portion of the West Pasture is reflected in the fact that the “Freshwater Marsh” lies directly adjacent to an area dominated by halophytic species such as pickleweed and saltgrass. For this reason, this marsh would probably not qualify as a CNDDB special habitat.

Conversely, Olema Marsh might qualify as a CNDDB special habitat, as it is permanently flooded with freshwater, with saline incursions limited to the “mouth” of the marsh where Bear Valley Creek flows underneath Levee Road. In addition, it has deep, peaty soils dominated by tall emergent, perennial monocots. In his taxonomic treatment of Marin flora, Howell (1970) characterized Olema Marsh as “perhaps the best freshwater marsh area in the county.” However, as pointed out earlier, based on 1862 maps, Olema Marsh appeared to be part of a large tidal marsh complex historically and was probably converted from a brackish to a freshwater marsh by construction of Levee and, later, Bear Valley Roads (Parsons and Allen 2004b). Ironically, then, this hallmark freshwater marsh feature is probably an artifact of anthropogenic disturbance. Even after roads were constructed, Olema Marsh apparently has continued to change both hydrologically and floristically, with increasing water levels within the marsh in recent decades drowning out some of the perimeter riparian vegetation. Ultimately, the fact that Olema Marsh is probably not a natural freshwater system might argue against its inclusion as a CNDDB Natural Community.

Special Status Plant Species

Regulatory and Policy Setting

Numerous species of plants have undergone local, state, or national declines, which have raised concerns about their possible extinction if they are not protected. Special status plant species include those that are legally protected under the federal and California Endangered Species Acts (ESA) or other regulations and those that are considered rare by the scientific community or the Seashore. Special status species can include:

- plants that are listed or proposed for listing as threatened or endangered under the federal ESA (50 CFR 17.11 for animals; various notices in the Federal Register [FR] for proposed species) and/or the California ESA (Fish and Game Code §2050 *et seq*.; 14 CCR §670.1 *et seq*.);
- plants that are candidates for possible future listing as threatened or endangered under the federal ESA (61 FR 7506 February 28, 1996);
- plants that are designated as “species of concern” (former category 2 candidates for listing) by the U.S. Fish and Wildlife Service (USFWS) or “species of special concern” by the California Department of Fish and Game (CDFG);
- plants that meet the definition of rare or endangered under the California Environmental Quality Act (CEQA) (14 CCR §15380), which includes species not found on state or federal endangered species lists;
- plants listed under the California Native Plant Protection Act (Fish and Game Code §1900 et seq.);
- plant species that occur on California Native Plant Society (CNPS) lists; and
- plant species that the Seashore deems locally rare or of special concern, even though they are not officially listed.

The federal ESA of 1973, as amended, requires federal agencies to consult with the USFWS before taking actions that (1) could jeopardize the continued existence of any federally listed plant or animal species (e.g., listed as threatened or endangered) or species proposed for listing, or (2) could result in the destruction or adverse modification of critical or proposed critical habitat. The USFWS has provided the Seashore a list of special status species that have potential to occur in the Seashore, north district of the GGNRA, and Marin County. A list of these species is provided in Appendix A.

The Council of Environmental Quality Regulations for Implementing the National Environmental Policy Act (Section 1508.27) also requires considering if an action may violate federal, state, or local laws or requirements imposed for the protection of the environment. As with special habitats or Natural Communities, CDFG has created a CNDDB of known or reported occurrences of threatened, endangered, rare, or CNPS-listed species within California. Information from the CNDDB on special status plant species within quadrangles in the Seashore and north district of the GGNRA is incorporated into Appendix A, although not all known occurrences within the Seashore and the GGNRA have been reported to the CNDDB historically.

Beyond regulatory mandates to avoid or minimize impacts to special status species, the Park Service Management Policies (2006) encourage parks to strive to recover all federally listed threatened, endangered, or candidate species within park boundaries and to restore their critical habitats. The Park Service also will inventory, monitor, and manage all state and locally species in a manner similar to that of federally listed ones (Section 4.4.2.1.; NPS 2006). Park managers should ensure that park operations do not adversely impact endangered, threatened, candidate, or sensitive species and their critical habitats either within or outside the park and must consider federally and state-listed species and other special-status species in all plans and NEPA documents (NPS-77 Natural Resource Management Guidelines).

Special Status Plant Species Resources within the Project Area

A list of 92 special status plant species with potential to occur in the Project Area is provided in Appendix A**.** This table was prepared using information from the USFWS (2005), CNDDB (2005), and the CNPS Rare Plant Inventory (2005). It also contains information on regulatory status, habitat, and flowering period derived from the CNDDB (2005) and CNPS Rare Plant Inventory (2005). The plant species listed in Appendix A occur in a variety of habitats present in Marin County, including freshwater marshes, coastal salt marsh, coastal prairie, coastal dunes, coastal scrub, riparian scrub, chaparral, valley and foothill grassland, serpentine areas, broadleaf upland forest, and closed-cone and coniferous forest (NDDB 2005). Approximately 30 of the special status species with potential to occur in the Study Area are found in wetland features such as coastal salt marsh, brackish marsh, freshwater marsh, bogs and fens, vernal pools, and seasonal wetlands.

Of the 92 plant species with potential to occur in the Project Area and vicinity, there appeared to be at least the general type of habitat for 61 of those (Parsons 2003). However, the number of species with real potential to occur in the Project Area is probably lower (Parsons 2003). Some of the 92 plant species -- Delta mudwort (*Limosella subulata*; CNPS List 2), Mason's lilaeopsis (*Lilaeopsis masonii*; FSC; SR; CNPS List 1B), and Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*; FSC; CNPS List 1B) -- that were recorded as occurring in Marin County appear to have resulted from erroneous identifications, as they have never been observed outside the Sacramento Delta or San Francisco Bay areas (Parsons 2003). Secondly, some of the habitats identified as occurring within the Project Area are very disturbed (e.g., many of the areas mapped as freshwater marsh or seasonal wetlands) and therefore marginal in terms of potential for rare plants (Parsons 2003). Third, some of the terms in the CNDDB such as "freshwater marsh" cover wide variations in this general type of habitat, with most of these species tending to occur in a very specific type of that general habitat (e.g., Sonoma alopecurus; Parsons 2003).

Focused surveys documented the presence of six special status species in the Project Area (Parsons 2003; NPS, *unpub*. *data*; Figure 35). Three are former Federal Species of Concern that have been designed as Species of Regional Concern by the Sacramento USFWS office: Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*; former FSC; FSRC; CNPS List 1B), Humboldt Bay owl's-clover (*Castilleja ambigua* ssp. *humboldtiensis*; former FSC; FSRC; CNPS List 1B), and Marin knotweed (*Polygonum marinense*; former FSC; FSRC; CNPS List 3). In addition to these three species there are two other Species of Regional Concern: Pacific cordgrass (*Spartina foliosa*) and salt marsh owl's-clover (*Castilleja ambigua* ssp. *ambigua*). Lastly, Lyngbye's sedge (*Carex lyngbyei*), a CNPS List 2 species, has also been observed.

Two species, Humboldt Bay owl's-clover and Lyngbye's sedge, have been recorded within the Giacomini Ranch (Parsons 2003, NPS, *unpub. data*). Point Reyes bird's-beak was observed exclusively in diked and undiked marsh habitats north of the Project Area. A very small patch of another salt marsh species, Marin knotweed also occurred in the undiked marsh north of the Giacomini Ranch, but some distance away from the Giacomini Ranch. Surveys in Olema Marsh did not uncover any rare plant species (Ryan and Parsons, *in prep*.), and the potential habitat for most of the freshwater marsh species is poor. Acreage of habitat for special status species that are directly in the Project Area is listed below in Table 14.

FIGURE 35. SPECIAL STATUS PLANT OCCURRENCES

TABLE 14. ACREAGE OF SPECIAL STATUS PLANT SPECIES DIRECTLY IN THE PROJECT AREA

Common Name	Scientific Name	Acres
Point Reyes bird's-beak	*Cordylanthus maritimus* ssp. *palustris*	0.4
Humboldt Bay owl's-clover	*Castilleja ambigua* ssp. *humboldtiensis*	16.2
Pacific cordgrass	*Spartina foliosa*	0.9
Lyngbye's sedge	*Carex lyngbyei*	0.1

Point Reyes bird's-beak *(Parsons 2003)*: Point Reyes bird's-beak is a hemiparasitic annual herb that grows in the mid- to high marsh areas of coastal salt marshes. Marin County represents the southern end of the existing range for this species, which stretches into Oregon (CNPS 2005). It once occurred in Alameda, Santa Clara, and San Mateo counties, but the historical populations are believed to have been extirpated (CNPS 2005).

Point Reyes bird's-beak

In Marin County, Point Reyes bird's-beak occurs both in coastal salt marshes along the coast and in marshes on the margin of San Francisco Bay. Point Reyes bird's-beak has been documented in several locations within the Seashore and the north district of the GGNRA, principally in Drakes Estero, Limantour Marsh, and in marshes within Tomales Bay. Habitat for this species tends to encompass lower elevation high marshes. The preference for areas with sandy substrates and low-growing vegetation reflects the strong relationship between bird's-beak distribution and abundance and natural disturbance events such as wrack or alluvial material deposition or vegetation dieback that create openings suitable for recruitment and establishment (USFWS *in prep*.).

Humbolt Bay Owl's Clover

Throughout its range, this species has experienced a dramatic decrease in numbers due to impacts such as development, foot traffic, non-native plants, and altered hydrology (CNPS 2005). Within the Seashore and the north district of the GGNRA, the main threats to this species appear to be trampling and grazing by tule elk and cattle (PORE; P. Baye, *pers. comm*.). In the Project Area, there were four populations and/or groups of plants in the Pocket Marsh near Bivalve Channel, at the end of the Tomales Bay Trailhead, and in the undiked marsh directly north of the Giacomini Ranch. Most of these populations numbered several hundred to less than a thousand individuals (Figure 35).

***Humboldt Bay owl's-clover* (Parsons 2003).** This species is another hemiparasitic member of the Scrophulariaceae family that also grows in intertidal salt marshes, although its flowering time and microhabitat differ slightly from that of Point Reyes bird's-beak. This annual is listed as occurring in Humboldt and Marin counties (CNPS 2005). Within the Seashore and north district of GGNRA, it occurs commonly in intertidal salt marshes along Drakes and Limantour Esteros and in the southern portion of Tomales Bay.

There has been some speculation that some of the populations in the Seashore and Tomales Bay might be taxonomically distinct from their northern, Humboldt County counterparts (P. Baye, *pers. comm*.). The Tomales Bay form is distributed in lower elevation and slightly wetter portions of marshes than plants in Humboldt County and has succulent, glabrous leaves and stems with white-tipped, truncate flower bracts (Parsons 2003, P. Baye, *pers. comm*.). In Tomales Bay, owl's-clover often co-occurs in the same intertidal zone (mid-marsh) with Point Reyes bird's-beak (USFWS *in prep*.), although it establishes at slightly lower elevations (Parsons 2003).

Threats to this species include loss of salt marsh habitat due to diking and filling for agriculture and urbanization (USFWS *in prep*.). Within the Seashore and GGNRA lands, severe cattle trampling and grazing pose a significant threat to populations of both subspecies (P. Baye, *pers. comm*.). Some of the largest remaining populations of this species, particularly of the Tomales Bay form, occur in the southern portion of Tomales Bay within the Project Area. There were six occurrences or "populations" within the Project Area that were located at the end of the Tomales Bay Trailhead, along the eastern and western undiked marsh fringes of Lagunitas Creek, and in the undiked marsh north of Giacomini Ranch (Parsons 2003). Occurrences numbered from just a few individuals to more than 10,000 plants in some years (Parsons 2003; Figure 35).

Marin knotweed *(Parsons 2003)*: This annual herb is found principally in Marin, Napa, and Sonoma counties (CNPS 2005). Few occurrences have been documented (CNPS 2005). Hickman (1993) noted that the taxonomic status of the species is uncertain and that it may either be related to *Polygonum aviculare* or may actually be *Polygonum robertii*, a non-native species from the Mediterranean. Populations of this species found within the Seashore have typically been small and spatially dispersed (M. Coppoletta, Seashore, *pers. comm*.). It is possible that the extent of Marin knotweed within the Seashore and the north district of the GGNRA has been underestimated due to the difficulty of seeing this non-descript plant (Parsons 2003). Only one occurrence of this species has been documented within the Project Area. One individual was observed growing on the undiked marsh deltaic island directly north of Bivalve Channel (Parsons 2003; Figure 35). The primary threat to this species has been characterized as salt marsh development (CNPS 2005).

Pacific cordgrass just north of the Giacomini Ranch

Pacific cordgrass. Pacific cordgrass (*Spartina foliosa*; FSRC) is a member of the grass or Poaceae family that colonizes the low intertidal zones between Mean Sea Level (MSL) and Mean High Water (MHW) in saline portions of estuaries. It often grows along the edge of tidal creeks and on tidal mudflats. Its tall height often contrasts sharply with the low-growing plants of the "mid-marsh" portion of tidal marshes. This particular perennial grass is endemic to central and southern California coastal salt marshes and is found as far south as Baja (Thompson 2001). Its northerly endemic range is Sonoma County (Strong and Daehler 1995), but it can be found in the far north of California, where it has been introduced into Del Norte County. This species occur in several areas within the Seashore, north district of GGNRA, and Tomales Bay.

Interestingly, prior to 1990, Pacific cordgrass had not been sighted in Tomales Bay during at least recent times, although it grew in Drake's and Limantour Esteros. In 1974, MacDonald and Barbour documented the "conspicuous absence" of Pacific cordgrass in Tomales Bay despite its extensive presence in San Francisco Bay and other central California estuaries (PWA et al. 1993). There has been some speculation that historic populations of this species may have been lost during the 1906 earthquake, when some portions of Tomales Bay sharply subsided (Peter Baye, *pers. comm*.). Baseline surveys conducted as part of the feasibility study for the proposed project found "several colonizing patches" of Pacific cordgrass at the mouth of Lagunitas Creek in late 1991 (PWA et al. 1993). Since then, numbers of this species have jumped exponentially, particularly at the seaward edge of the Lagunitas Creek delta, where numerous very distinctive, circular patches of cordgrass have colonized the expansive mudflats. Numbers also appear to be increasing substantially within the undiked portions of the Project Area, primarily along tidally influenced creeks such as Lagunitas Creek and tidal creeks in the undiked marsh north of Giacomini Ranch (Figure 35).

Unlike many other salt marsh species that have primarily been negatively impacted by development, the principal threat to Pacific cordgrass is the introduction of the non-native Atlantic cordgrass (*Spartina alterniflora*) to San Francisco Bay in the 1970s as part of a project (Ayres et al. 1999). Atlantic cordgrass, which is native to the Atlantic and Gulf coasts of the United States, immediately became an aggressive competitor with Pacific cordgrass, displacing the native species through both shading and growing over a broader tidal range. The severity of the threat increased when managers and scientists realized that Atlantic cordgrass was also hybridizing with the native species, making it much more difficult to recognize the non-native species in the field. Through genetic testing, scientists have been able to determine that most of the new occurrences of Atlantic cordgrass in San Francisco Bay are primarily hybrids (Invasive Spartina Project

2004). Based on recent surveys, Atlantic cordgrass hybrids have spread throughout the south and central portions of San Francisco Bay, but have yet to invade northern San Francisco Bay (Ayres et al. 1999). The Seashore has documented both Atlantic cordgrass and hybrids in Drake's Estero, but ISP has not yet found these species in Tomales Bay despite several years of survey. More detailed information on invasive *Spartina* species can be found later in this section.

Salt marsh owl's-clover *(Parsons 2003)*: This species (*Castilleja ambigua* ssp. *ambigua*) has distinct ecotypes that grow in salt marshes, as well as coastal grasslands (USFWS *in prep*.). While this species is not formally listed by the USFWS, CDFG, or CNPS, the rarity of the salt marsh ecotype within the San Francisco Bay region could eventually lead to salt marsh owl's clover being considered a species of regional significance. As with *Castilleja ambigua* ssp. *humboldtiensis* (former FSC; CNPS List 1B), this species grows in intertidal salt marshes, although its flowering time and microhabitat differ slightly. Within salt marshes, subspecies *ambigua* tends to establish at higher elevations near Mean High Higher Water (MHHW) that are often ecotonal to grasslands and is distinguished from subspecies *humboldtiensis* by its hairy stems and leaves. Once described as "common along the borders of salt marshes" in the late 19^{th} century (Greene 1894; USFWS *in prep.*), salt marsh owl's clover is nearly extirpated in the San Francisco Bay estuary, with only one large modern population in Contra Costa County and potentially a few others in San Pablo Baylands remaining (USFWS *in prep*.). There are a few, usually small, salt-tolerant populations of this species along central California coastal marshes outside San Francisco Bay, including at Rodeo Lagoon, Marin Headlands, Pine Gulch Creek in Bolinas Lagoon, Limantour Marsh, and Tomales Bay Trailhead marsh (USFWS *in prep*.). Within the Seashore and GGNRA lands, severe cattle trampling and grazing pose a significant threat to populations of both subspecies (P. Baye, *pers comm*.).

Lyngbye's sedge. Lyngbye's sedge (*Carex lyngbyei*), a member of the sedge or Cyperaceae family, is a perennial herb that is native to California and is also found elsewhere in North America and beyond (CalFlora 2006). It is included by the CNPS on its List 2, which contains species that are rare, threatened, or endangered in California, but common elsewhere (CNPS 2005). Marin County is the southern extent of its range in California, which extends north into Del Norte and Humboldt Counties and into Oregon. Within Marin County, it has been documented in the Inverness and Bolinas USGS quadrangles (CNPS 2005), although the Seashore has no documentation of its presence within park boundaries (NPS, unpub. data). Howell (1970) described it as occurring in the "Salicornia (pickleweed) belt of the salt marsh along Tomales Bay near Inverness," which is the southernmost known California station. USFWS noted that this species "almost always occurs under natural conditions in wetlands" (USFWS *in* Calflora 2006). Within the Project Area, Lyngbye's sedge was observed in a moderately sized patch on a Tidal Marsh "shelf" on the outboard side of the East Pasture levee and a small patch with a few individuals in the undiked marsh just north of the Giacomini Ranch's West Pasture (Figure 35).

Threats from Non-Native and Invasive Plant Species

As was evident in the description of Pacific cordgrass, the presence of invasive or non-native species can pose a real threat to the viability and integrity of native or natural vegetation communities. These species can not only displace individual native species, thereby increasing the potential for their extinction, but change entire landscapes, such as the apparent large-scale conversion in California from perennial bunchgrass-dominated to non-native annual-dominated grasslands over the last few centuries that has supposedly now given the state its golden hued hills. In addition, invasive and non-native species can alter the physical and biological processes of ecosystems in ways that are sometimes hard to discern, but that have tremendous impacts on food web and population viability dynamics.

Within the Project Area, the presence of invasive non-native plant species was documented through vegetation mapping, although the specific location and areal extent of occurrences of specific "problem" species were not necessarily mapped unless the occurrence was relatively large (e.g., stands of eucalyptus; Parsons and Allen 2004b). Invasive species were defined as those ranked by the California Invasive Plant Council (CalIPC) or by the Seashore as a significant threat to native ecosystems of California and/or the parks. CalIPC relies on a categorical system of ranking the seriousness posed by invasive species, with "High" comprising the most invasive ones and the list, "Limited," the least invasive. CalIPC just recently revised its list and ranking system since the last version was introduced in 1999.

The Seashore also manages a comprehensive weed removal program that has targeted a number of this CalIPC species, but that has focused on some very high priority species that include pampas grass (*Cortaderia* spp.), French broom (*Genista monspessulana*), Scotch broom (*Cytisus scoparius*), cape ivy (*Delairea odorata*), eucalyptus (*Eucalyptus* spp.), European dune grass (*Ammophila arenaria*), and iceplant (various species). The Park Service is directed to manage and eradicate invasive plant and animal species that "interfere with natural processes and the perpetuation of natural features, native species, or natural habitats…" (NPS 2006; Section 4.4.4.2).

Approximately 49 CalIPC invasive species occurred in the Project Area (Parsons and Allen 2004b). Although the number of species is relatively high, the number of occurrences and/or areal extent of most of these plants remained comparatively low (Table 15; Parsons and Allen 2004b). Of the 49 species, nine were on the "High" List, which includes the most invasive and widespread invasive species. The most common "High" threat species in the Project Area were fennel (*Foeniculum vulgare*) and Himalayan blackberry (*Rubus discolor*), with Himalayan blackberry acreage in the Project Area totaling 9.36 acres (Table 15). Himalayan blackberry represented a common riparian understory or shrub species, although California blackberry (*Rubus ursinus*) appeared to have a higher percent cover (Parsons and Allen 2004b). Fennel primarily establishes in Ruderal and Disturbed habitats along levees, berms, and other areas. Only two (2) patches of pampas grass (*Cortaderia jubata*) have been observed in the Project Area, with acreage totaling less then 0.01 acres (Table 15). Some efforts at eradicating at one of these patches have already been undertaken under the Seashore's Exotic Management Plan. Cape ivy (*Delairea odorata*) and English ivy (*Hedera helix*) occurred in the riparian habitat adjacent to Sir Francis Drake Boulevard in scattered patches totaling less than 0.4 and 1.8 acres, respectively (Table 15), but, due to these species' invasiveness, their presence represents a threat, because of the proposed project's objective of increasing riparian habitat.

TABLE 15. ACREAGE OF THE DOMINANT INVASIVE NON-NATIVE PLANT SPECIES

Common Name	Scientific Name	Acres
Himalayan blackberry	*Rubus discolor*	9.36
Fennel	*Foeniculum vulgare*	2.77
English ivy	*Hedera helix*	1.79
Poison hemlock	*Conium maculatum*	0.41
Cape ivy	*Delairea odorata*	0.40
Periwinkle	*Vinca major*	0.30
	Phalaris aquatica	0.25
Pampas grass	*Cortaderia jubata*	0.01

Twenty-six (26) species on CalIPC's "Moderate" invasives list have been documented in the Project Area, including both regional and widespread invasives (Parsons and Allen 2004b). Of these 26 species, six were very common in the Project Area: bull thistle (*Cirsium vulgare*), poison hemlock (*Conium maculatum*), tall fescue (*Festuca arundinacea*), common velvet grass (*Holcus lanatus*), Italian ryegrass (*Lolium multiflorum*), and pennyroyal (*Mentha pulegium*). Most of these species preferentially established in disturbed areas such as levees or near barns, roads, etc. Densities of Italian thistle and bull thistle typically remained low in polygons in which they occurred, but poison hemlock and tall fescue were often found in dense clumps on levees and within pastures, respectively. Pennyroyal, an obligate hydrophyte or wetland species, was relatively common (88 polygons) in some of the freshwater wetland vegetation communities such as Wet Pasture and Freshwater Marsh. Other Moderate Invasiveness species such as greater periwinkle (*Vinca major*) are less common and restricted to riparian areas, but it, as with Cape ivy, represents a threat to riparian restoration efforts.

Riparian understory dominated by Cape Ivy

Interestingly, common velvet grass, which is strongly threatening the integrity of the parks' coastal grasslands through rapid colonization of coastal prairies and dairy cattle ranches, was not as common as other grasses within the Project Area, nor was Italian ryegrass, which is found in overwhelming numbers in many San Francisco Bay region counties such as Sonoma (Parsons 2005). Conversely, some of the grasses on the Limited Invasiveness list were extremely common, including creeping bent (*Agrostis stolonifera*) and annual beardgrass (*Polypogon monspeliensis*).

Some species that were not on the CalIPC list, but are of great concern to the Seashore, north district of GGNRA, and others are eucalyptus (*Eucalyptus* sp.), giant reed (*Arundo donax*), perennial pepperweed (*Lepidium latifolium*), and Atlantic cordgrass (*Spartina alterniflora*) and its hybrids with the native cordgrass, Pacific cordgrass (*Spartina foliosa*). Giant reed (*Arundo donax*) does not currently grow in the Project Area, but there are two currently non-spreading occurrences upstream of the Project Area on Olema Creek and tributaries to Lagunitas Creek (Brannon Ketcham, Seashore, *pers comm*.). Eucalyptus was primarily found growing in large stands along Point Reyes Mesa on private lands.

As was described under Special Status Species section, the native cordgrass species, Pacific cordgrass, has been designated a Species of Regional Concern due to the fact that non-native, invasive Atlantic cordgrass hybrids have been rapidly displacing it in San Francisco Bay. The 2004 Invasive Spartina Project (ISP) found that the distribution of introduced *Spartina* species throughout the San Francisco Estuary had not changed significantly since the 2001 Bay-wide inventory survey, with most of the hybridized plants remaining in the southern and central portions of San Francisco Bay (ISP 2004). However, the population had spread to 734 net acres, up 52 percent from the 2001 estimate of 482 net acres (ISP 2004). In addition, dense-flowered cordgrass (*Spartina densiflora*) hybrids have also been found in several eastern Marin County marshes (ISP 2004). Atlantic cordgrass and hybrids have also been discovered in Drake's Estero, and the Seashore has been vigorously treating them through tarping to try and eliminate this threat to outer coast populations of Pacific cordgrass. ISP has been conducting surveys in Tomales Bay for Atlantic cordgrass and hybrids during recent years and has yet to discover any, although at least two occurrences of dense-flowered cordgrass have been recorded historically within the Bay.

The other strong threat to salt marsh vegetation communities comes from perennial pepperweed, which has severely invaded many of the high marsh and upland ecotonal areas and levees within San Francisco Bay marshes. In some areas in the northern and southern reaches of the San Francisco Bay Estuary, pepperweed grows in dense stands over extensive areas (May 1995). While this species is capable of establishing in almost any environment, its advance appears primarily confined to wetland (May 1995). Pepperweed is an excellent competitor, growing early in the season, producing a large seed set as well as spreading by rhizomes, able to colonize bare mineral soil, and possibly allelopathic (J. Collins, SFEI, pers. comm.; Corliss 1993; Trumbo 1994). The most recent sighting of this species occurred in 2005 in Walker Creek marsh, where Seashore staff observed and attempted to remove several small patches growing on the alluvial levee and an in-channel island. However, pepperweed has apparently also been observed in the past in the Bivalve Channel just north of the Giacomini Ranch (P. Baye, *pers. comm*.).

In general, while the Project Area supports hundreds of non-native species as do many other "wild" and managed areas in California, there are very few invasive species of concern, and these, at least currently, have limited distribution. The invasive species of most concern are cape ivy, pampas grass, English ivy, and, perhaps, greater periwinkle, all of which are associated with or can grow in riparian habitat.

Vegetation Resources and Wetland Functionality

As described in the beginning of this section, vegetation plays a key and prominent role in wetland functionality, particularly for floodwater retention, dissipation of flood flow energy, water quality improvement, and wildlife use and habitat. The effectiveness of vegetation within the Giacomini Ranch in slowing and dissipating the energy of flood flows and improving water quality has not been quantitatively evaluated. However, the predominance of the rather monotypic, low-growing Wet Pasture vegetation community within the pastures, along with relatively sparse amount of riparian vegetation cover along creek banks, would suggest that the ability of vegetation to reduce flood flows has been decreased potentially relative to natural systems. In addition, microtopographic variability within the pastures has been substantially reduced through land-leveling activities, which would also decrease the ability of these areas to dissipate flood flows once floodwaters overtop levees.

The relationship between vegetation and wildlife habitat will be discussed in the Fish and Wildlife Section, but grazing and mowing of vegetation, along with diking, has also minimized the ability of vegetation communities within the Giacomini Ranch and, to some extent, Olema Marsh to contribute to carbon export to Tomales Bay. Through intensive study during the 1980s and 1990s, researchers participating in the LMER program concluded that Tomales Bay is a heterotrophic estuary that receives most of the organic matter used or broken down by organisms from outside sources such as the surrounding watershed lands and fringing marshes (Chambers et al. 1994). Historic tidal marshes such as Giacomini Ranch and Olema Marsh may have played a key role historically in helping to support the food web within this estuary. Interestingly, dredging of drainage ditches to remove aquatic vegetation does appear to have elevated dissolved organic carbon levels in waters relative to undiked marshes, probably because of accelerated breakdown of decaying organic matter and vegetation (Parsons, *in prep*.). However, this carbon cannot be exported to Tomales Bay because of diking and installation of one-way tidegates. Furthermore, the lack of hydrologic connectivity in both the Giacomini Ranch and Olema Marsh, along with removal or suppression of riparian establishment in the

Giacomini Ranch, has also minimized the ability of the Project Area to contribute large woody debris to surrounding waterways for use by aquatic organisms.

Fish and Wildlife Resources

One of the most important functions associated with wetlands and riparian areas is the habitat that they provide for wildlife species. Some wildlife species use creeks, wetlands, and riparian habitat for a portion of their life cycles such as breeding or spawning, foraging, refugia, or as a migration corridor. Others are resident species that spend their entire lives within these systems. Adjacent uplands not only support wildlife typically considered upland species, but are also important to wetland- and riparian-associated species for refugia during high tides or high freshwater storm flows, foraging, movement between sites, etc. Most of the Project Area supports wetland and riparian vegetation, as well as some upland, communities that provide important habitat for common and special status wildlife species. The value of the Project Area to fish and wildlife is integrally tied, of course, to the overall value and importance of the Point Reyes region and Tomales Bay watershed.

Some wildlife species use creeks, wetlands, and riparian habitat for a portion of their life cycles such as breeding or spawning, foraging, refugia, or as a migration corridor. Others are resident species that spend their entire lives within these systems.

Fish and Wildlife Resources Setting

The incredible geologic, hydrologic, and floristic diversity within the Point Reyes region has led to a tremendous diversity in the wildlife that use or visit this area. The juxtaposition between the marine environment of the Pacific Ocean and the terrestrial environment of the rugged Marin coastline, combined with the sheltered estuarine environment of Tomales Bay and other embayments, translates into an amazing breadth of habitat types or ecological niches for animals. It is largely because of this habitat diversity that Point Reyes has become world-renowned for its importance to marine, estuarine, and terrestrial wildlife species.

Point Reyes falls within the UNESCO-designated Golden Gate Biosphere Reserve, a partnership of 13 protected areas in the larger San Francisco Bay region. Largely because of its importance to wildlife, Tomales Bay has been designated as a Wetland of International Importance by the Ramsar Convention and is one of only 22 sites in the United States with this designation. Tomales Bay is also one of 16 "wetlands" that qualifies for inclusion as a wetland of regional importance under the Western Hemisphere Shorebird Reserve Network because of its large number of wintering and migrating shorebirds, which number more than 20,000 (Kelly 2001). Within the coastal waters directly offshore of Marin County, there are four of California's 34 Areas of Special Biological Significance (ASBS) and two of only 11 national marine sanctuaries in the United States. In some ways, this recognition of the value of Point Reyes and Tomales Bay to wildlife reflects the larger importance of California, which has been recognized as only one of two Biodiversity Hotspots within the continental United States by Conservation International. The entire San Francisco Bay area was characterized as one of the highest, if not the highest, ranked regions in terms of being a Hot Spot of Species Rarity and Richness by NatureServe (2000).

This biodiversity is evident in the number of species that use this area or call it home. The Point Reyes region supports 28 species of reptiles and amphibians, 65 species of mammals, and breeding habitat for 130 species of birds. As many as 32 of these are listed as federally endangered or threatened. Nearly 490 bird species -- representing 45 percent of the avian fauna documented in the United States -- have been sighted on land and over near shore waters at Point Reyes. The Point Reyes area has more varieties of birds than 20 other individual states (J. Kelly, ACR, *pers. comm*.). Point Reyes, Tomales Bay, and other open water areas on the Marin coast are important stops for migratory species on the Pacific flyway and provides important alternate habitat for birds using San Francisco Bay, the largest estuary in California. Some of what draws overwintering and migrant bird species, as well as resident wildlife, are the richness and diversity of aquatic life within the waters of the Pacific Ocean and Tomales Bay. Tomales Bay represents the second largest Pacific herring spawning estuary in California and supports one of the largest remaining coho salmon (*Oncorhyncous kisutch*) populations along the central California coast. These resources attract several hundred seals and sea lions every winter that come here to pup. Point Reyes is one of only four mainland breeding areas worldwide for northern elephant seals (*Mirounga angustirostris*) and provides haul-out and pupping areas for 20 percent of the mainland California population of harbor seals (*Phoca vitulina*).

Regulatory and Policy Setting

Many wildlife species within the United States have been adversely impacted by increasing urbanization, resource extraction, contamination from pesticides, metals, and other pollutants, and introduction of non-native wildlife species. A number of regulations and policies have attempted to protect wildlife from these negative impacts, with most of these focused either on preservation of key or critical habitat or protection and recovery of the species itself. Some of the habitat protection is accomplished directly through the establishment of Critical Habitat under the federal Endangered Species Act (ESA) or Essential Fish Habitat or California's Lake and Streambed Alteration Agreement (Section 1600; see Vegetation Resources) and LCP Zone II's policies on Environmentally Sensitive Habitats. Marin's draft CWP (2005) is proposing to establish policies for protection of essential habitat for special status species, wildlife nursery areas, movement corridors, and ecotones, because of their importance to wildlife. CCC policy focuses on maintenance, enhancement and, where feasible, restoration of marine resources, particularly areas and species of special biological significance (Article 4, Section 30230). In other cases, habitat protection largely comes indirectly from other legislation aimed at protecting wetlands and riparian habitat for water quality and other purposes under Sections 404 and 401 of the Clean Water Act and under the Streamside Conservation Areas and upland buffer areas around wetlands policies under the LCP for Zone II.

In addition to habitat, federal and state agencies have moved to protect individual species under federal and state ESA. The federal ESA protects threatened and endangered species from unauthorized "take", and directs federal agencies 1) to ensure that their actions do not jeopardize the continued existence of listed species or result in the destruction or adverse modification of Critical Habitat and 2) to utilize their authorities by carrying out programs for conservation. Section 7 of the act defines federal agency responsibilities for consultation with the U.S. Fish and Wildlife Service (USFWS) for most mammal, bird, and fish species or with the National Marine Fisheries Service for anadromous or ocean-going fish. Once a species has been listed under the federal ESA as threatened or endangered, the USFWS is required to identify and protect Critical Habitat. Even bird species that are not necessarily protected under federal or state ESA receive some protection under the Migratory Bird Treaty Act of 1918 (16 U.S.C. §703-712). The Migratory Bird Treaty Act protects almost all migratory wild birds and their parts (including eggs, nests, and feathers) and makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird or to cause a "taking," which is defined as disturbance that causes nest abandonment and/or loss of reproductive effort (e.g., killing or abandonment of eggs or young). Policies in the Point Reyes Station Community Plan (Marin County Community Development Agency 2001) specifically identify "protection of Lagunitas Creek, specifically its water quality, coho salmon and steelhead populations, and other aquatic life."

Beyond regulatory mandates, the Park Service Management Policies (2006) require parks to preserve and restore the natural abundances, diversities, dynamics, and habitats of native animal populations and the communities and ecosystems in which they occur (NPS 2006; Section 4.4.1). The Park Service is also specifically urged to not only avoid impacts to threatened or endangered species, but to look for opportunities to increase, restore, or reintroduce them when these habitats or species have been threatened or extirpated (NPS 2006; Section 4.4).

Fish and Wildlife Habitats

While vegetation communities are often strongly correlated with fish and wildlife habitats, particularly in terrestrial zones, groupings of plant species in and of themselves cannot fully define habitats that are of value to animal species. This is particularly true in marine and estuarine environments where many of the important habitats are "plant-less" or primarily water- and substrate-based such as pools and riffles in streams, intertidal mudflats in estuaries, and sandy beaches. Even in vegetated areas, variation in plant species composition or assemblages may be meaningless to wildlife that focus more on the architecture or diversity of plant or canopy (foliage) heights or the size and number of vegetation "patches." Some species, of course, have developed strong linkages with particular plant species such as the Myrtle's silverspot butterfly (*Speyeria zerene myrtleae)* and its caterpillars, which exclusively feed on members of the violet family. The number of truly dependent relationships between animals and particular plant species is relatively small, however, which might suggest that wildlife are largely not dependent on native plant species as long as non-native species perform similar ecological roles.

Managers and scientists continue to debate the importance of native versus non-native species to wildlife, particularly as some wildlife species now frequently use non-native species for breeding, nesting, or foraging. Non-native plant species can subtly alter the dynamics of vegetation communities and habitats in such a way as to make them less valuable to wildlife. Invasion into riparian habitat by the low-growing herb greater periwinkle (*Vinca major*) dramatically suppresses establishment of shrubs that provide important habitat for certain riparian avifauna. In addition, establishment of taller riparian invasives such as giant reed (*Arundo donax*) and salt cedar (*Tamarisk* sp.) seem to be associated with decreases in insect populations, and these decreases can negatively affect insectivorous riparian birds (CNPS Policy on Invasive Plant Species (2006).

Ultimately, while terrestrial wildlife habitats are often strongly associated with vegetation, the value of particular habitats for wildlife is often driven by numerous landscape-level and site-level factors such as lack of fragmentation or gaps in habitat “corridors;” habitat or “patch” diversity; the amount of edge habitat relative to interior habitat; canopy closure of trees; hydrology; soils or substrate; and the amount of light penetration in waters, etc. Below is a description of fish and wildlife habitats in Tomales Bay and the Project Area.

Tomales Bay

The diversity of wildlife species using Tomales Bay directly relates to the diversity of habitats present. This diversity is enhanced by the juxtaposition between marine and freshwater influences. Unlike the mouth of Elkhorn Slough in Monterey Bay, which deepens abruptly into a large submarine canyon directly offshore, the Pacific Ocean in Point Reyes and surrounding areas is relatively shallow due to the presence of the Continental Shelf that juts out at least one-quarter mile offshore, creating a light-infused, relatively warm marine environment that supports large kelp and seagrass forests, as well as rocky reefs and sandy bottom habitats. As with other areas along the California coast, strong northeasterly winds produce along this shelf an upwelling effect or turnover of deeper waters that are rich in nutrients and, therefore, very attractive to many aquatic organisms (Smith and Hollibaugh 1998). As the shelf steepens inland, marine subtidal habitats transition into rocky and sandy intertidal zones that are exposed for some period during low tides and are subject to wave action. The westward portion of the Point Reyes Peninsula is largely dominated by expansive sandy beaches that abruptly convert to rocky shoreline on the eastern-facing slopes of Tomales Point adjacent to Tomales Bay.

This shallowing trend continues as the Pacific Ocean moves into Tomales Bay. With a large source of fine sediments coming from its upper watershed, the muddy bottom of Tomales Bay provides a sharp contrast to the sandier and rockier habitats of the Pacific Ocean. Deposition and resuspension of both fine sediment and sands within the Bay has created substantial variation in bathymetry or the topography of the Bay’s bottom from the outer to the inner portions, offering both shallow and deeper water habitats, with some subtidal areas being as deep as 56 feet. Some of the shallow waters that are protected from fast currents support large eelgrass (*Zostera marina*) forests. As of the late 1980s, Tomales Bay had approximately 37 eelgrass beds covering approximately 969 acres, predominantly in the northern or outermost portion of the estuary (Spratt 1989).

During low tides, shallow intertidal areas become exposed mudflat or tidal flats. As was described under Hydrologic Resources, the amount of intertidal mudflat in Tomales Bay has probably increased since the early to mid 1800s, because of the high amount of sedimentation once the watershed became more heavily developed. However, some of these mudflats are being converted to vegetated tidal marsh by colonization of Pacific cordgrass, which was once apparently absent from the Bay (MacDonald and Barbour 1974), but has increased exponentially in cover since the early 1990s. Low marsh areas dominated by Pacific cordgrass have not only colonized mudflats or tidal flats, but started fringing estuarine sloughs and creeks within tidal marshes. These low marsh areas either subtly grade or sharply transition into the mid-, high, and even upland ecotone habitats of salt marshes. As with intertidal mudflats, the acreage of intertidal wetlands in Tomales Bay has almost doubled between 1862 and the present because of the substantial increase in sedimentation.

Movement of the Pacific and Continental Plates along the San Andreas Fault has created topographic relief that enhances habitat diversity. Within the Bay itself, upland islands have emerged along the fault. The moderate – to steep topographic relief of the Inverness Ridge and the coastal marine terraces on the east side of Tomales Bay have created very different habitats within close proximity to the Bay, including mixed broadleaf evergreen and conifer forest on the west and rolling grasslands and occasional stands or forests of oak (*Quercus* sp.) on the east.

The diversity of niches and habitats for wildlife in Tomales Bay can be defined not only vertically by topography, but horizontally by salinity. The broad transition from freshwater to brackish environments within the estuary and from brackish to marine environments within the ocean increases the potential for species richness and diversity. Salinity can create ecological niches not only within vegetated areas, but within the water column itself. Many species are restricted by physiological tolerance to specific salinity regimes. Other species seem to thrive under specific salinity regimes, even migrating to some extent with specific salinity gradients as it changes throughout the year in response to freshwater inflow, tides, and evapotranspiration. As was described under Water Resources – Water Salinity, the Low Salinity Zone or X2, which generally approximates 2 psu or ppt, is often correlated with the presence of particular taxa and species, including certain species of copepod, mysid shrimp, and fish (Kimmerer 2004).

The salinity gradient even promotes diversity in vegetated habitats by creating freshwater, brackish, and salt marsh communities. While most systems show this type of diversity only in a longitudinal gradient, the presence of groundwater seeps and springs along the base of many of the ravines and valleys in this watershed has added a latitudinal component, as well, often creating a perimeter of freshwater or brackish marsh or riparian habitat around the perimeter of tidal marshes, thereby increasing habitat diversity.

Project Area

Considering the high diversity of vegetation and aquatic communities mapped in the Project Area, it is not surprising that the Project Area has a high diversity of fish and wildlife habitats. The Project Area is located in one of the largest estuarine transition zones or interface areas between saltwater and freshwater in Tomales Bay. Wetland and aquatic habitats include open bay, estuarine sloughs and creeks, tidal flats, tidal marsh, brackish and freshwater marsh, riparian thickets, and flooded pastures and meadows (Avocet Research Associates (ARA) 2002). Terrestrial or upland habitats in the immediate vicinity include mixed broadleaf evergreen forest, conifer forest, coastal scrub, coastal grassland, and remnant coastal prairie, as well as certain drier portions of the pastures within the Giacomini Ranch (ARA 2002). Using the vegetation map developed by the Seashore in 2002-2003 (Parsons and Allen 2004b), existing wildlife habitat conditions have been characterized in the Project Area using a combination of canopy architecture or elevation zone (i.e., general height of dominant plant species or intertidal elevation "zone"), hydrologic regime (e.g., seasonally flooded, permanently flooded, intertidal, etc.), and management regime (i.e., highly managed, lightly managed, ruderal, unmanaged; Figure 36).

The value of these habitats for wildlife relates primarily to the diversity and/or rarity of species using these habitats or the abundance of individuals of particular species (J. Evens, ARA *pers. comm*.). High value wildlife habitats support an abundance of different types of wildlife species (e.g., birds, mammals, invertebrates, fish, etc.) or high numbers of a particular type of wildlife group or guild (i.e., areas supporting large numbers of shorebirds or shorebird species) and/or provide important breeding, nesting, or adult habitat for endangered or threatened species that is critical to their continued viability or recovery. Some of the high value habitats in the Project Area include Tidal Salt Marsh, Seasonally Flooded-Ponded Muted and Non-Tidal Brackish Marsh, Forested and Scrub-Shrub Riparian Habitat, Freshwater Marsh, and Mesic Coastal Scrub, A list of characteristic species assemblages and acreages of high value wildlife habitats in the Project Area can be found in Table 16. Listed below are detailed descriptions of wildlife habitats that occur in the Project Area.

FIGURE 36. WILDLIFE HABITAT

Giacomini Ranch – West Pasture. In general, habitat diversity within the West Pasture remains highest on its western perimeter due to a number of potentially interrelated factors, including increased topographic and hydrologic complexity combined with less active agricultural management (Figure 36). On the western side of the Project Area, mixed broadleaf evergreen forest and conifer forest or Woodlands dominate the steep and rugged sides of the Inverness Ridge. These forests stretch from the top of the Ridge, whose highest point is Mt. Wittenberg, to its very base near Inverness Park and Inverness. Because of groundwater seeps and the prevalence of many small freshwater drainages flowing off the Ridge through steep ravines, riparian thickets of either Forested or Scrub-Shrub Riparian vegetation communities have established all along the toe of the Ridge, with the width of the corridor strongly influenced by amount of groundwater and freshwater flow and land management practices such as riparian removal, grazing, or replacement with horticultural species. Moving eastward, the fringing riparian thicket borders a variety of habitats, including Muted Tidal Brackish Marsh dominated by pickleweed (*Salicornia virginica*), Freshwater Marsh, and seasonally or temporarily flooded Meadows and Pasture-Grasslands. These diverse habitats transition primarily into temporarily flooded or saturated Meadows and Pasture-Grasslands, most of which are managed by some mowing during the summer. These meadows and pastures abruptly end on the eastern side of the West Pasture with Ruderal levees that have been primarily colonized by short and medium-sized weedy species such as non-native grasses, poison hemlock (*Conium maculatum*), and fennel (*Foeniculum vulgare*), as well as patches of some native species such as blue wildrye (*Leymus triticoides*).

The largest permanent Freshwater Marsh in the West Pasture occurs in the northwestern end of the West Pasture. The 7.2-acre West Pasture freshwater marsh supports a tremendous diversity of microhabitat types, with small to large patches of medium- and tall emergent species such as rush (*Scirpus microcarpus*), cattails, bur-reed, bulrush, and rush (*Scirpus americanus*) interspersed throughout a matrix of low-growing and floating emergents such as water parsley and hydrocotyle. Approximately 1.8 acres of Seasonally Flooded-Ponded Pasture-Grasslands south of Inverness Park along Sir Francis Drake Boulevard, which flood for an extended period during the spring into early summer, have less habitat diversity, with cover dominated by low-growing and floating emergent plant species exclusively.

Coho Salmon

TABLE 16. ACREAGE OF HIGH VALUE WILDLIFE HABITATS IN THE GIACOMINI RANCH AND OLEMA MARSH PORTIONS OF THE PROJECT AREA

Note: Table includes group, order, or class of organisms and representative species using these habitats. Numbers include portion of Lagunitas Creek in Project Area and part of undiked marsh north of the Giacomini Ranch. Boldface names indicate special status species.

High Value Wildlife Habitat	Group/Order/Class (time period/activity)	Representative Species	
Tidal Waters-Channel/ Subtidal and Intertidal TOTAL: 40.3	Mammals	**Southwestern river otter**	Harbor Seal
	Birds/Waterfowl	Greater scaup	Lesser scaup
	Birds/Waterbirds	Belted kingfisher Common loon	**California brown pelican** **California clapper rail**
	Birds/ Shorebirds	Greater yellowlegs Spotted sandpiper Dunlin	Dowitcher Willet
	Birds/Raptors	Osprey	
	Fish	Topsmelt Bay pipefish English sole Threespine stickleback Arrow goby Prickly sculpin	Staghorn sculpin **Steelhead** **Coho salmon** **Chinook salmon** **Tidewater goby**
	Invertebrates/Reptiles	Mysid shrimp	Northwestern pond turtle
Non-Tidal Waters-Channel and Pond with No Connectivity to Tidal Waters TOTAL: 3.0	Birds/Waterfowl	Mallard Gadwall	Wood duck Bufflehead
	Birds/ Waterbirds	Belted kingfisher Eared grebe Black phoebe Virginia rail	Sora Great egret Great blue heron Black-crowned night-heron
	Amphibians	**California red-legged frog** Bullfrog	Pacific tree frog
	Reptiles	**Northwestern pond turtle**	
	Fish	Threespine stickleback Arrow goby	Mosquitofish Longjaw mudsucker
Muted Tidal and Non-Tidal Waters-Channel with Connectivity to Tidal Waters TOTAL: 2.2	Birds/Waterfowl	Mallard Gadwall	Green-winged Teal
	Birds/ Waterbirds	Belted kingfisher Greater Yellowlegs Willet	**Green-backed heron** Great egret Great Blue heron
	Amphibians	**California red-legged frog**	
	Reptiles	**Northwestern pond turtle**	
	Fish	**Steelhead salmon** **Coho salmon** **Chinook salmon** **Tidewater goby**	Threespine stickleback Arrow goby Longjaw mudsucker Mosquitofish
Tidal Salt Marsh TOTAL: 29.6	Mammals	California vole	Shrews
	Birds/ Waterbirds	**California black rail** (Mid and High Marsh)	**Great egret**
	Birds/ Shorebirds (roosting)	Greater yellowlegs Godwits	Willets
	Birds/ Passerines	**Saltmarsh common yellowthroat**	Song sparrow
	Birds/ Raptors	**Short-eared owl** Northern harrier	White-tailed kite **Peregrine falcon**
	Fish (high tides)		
	Invertebrates	Gastropods Crustaceans	Amphipods (decomposers)
Tidal Brackish Marsh TOTAL: 4.8	Birds/ Waterbirds	Virginia rails	**California black rail**
	Birds/ Passerines	**Saltmarsh common yellowthroat**	Song sparrows Marsh wren
Muted Tidal Brackish Marsh-Mid and Tall TOTAL: 6.1	Birds/ Passerines	Saltmarsh common yellowthroat Marsh wren Song sparrow	Red-winged blackbird Savannah sparrow
	Birds/ Waterbirds	Virginia rail Sora	American coot Snowy egret

TABLE 16. ACREAGE OF HIGH VALUE WILDLIFE HABITATS IN THE GIACOMINI RANCH AND OLEMA MARSH PORTIONS OF THE PROJECT AREA

Note: Table includes group, order, or class of organisms and representative species using these habitats. Numbers include portion of Lagunitas Creek in Project Area and part of undiked marsh north of the Giacomini Ranch. Boldface names indicate special status species.

High Value Wildlife Habitat	Group/Order/Class (time period/activity)	Representative Species	
	Birds/ Shorebirds	Greater yellowlegs	Lesser yellowlegs
Muted Tidal Brackish Marsh – Mudflat/ Panne TOTAL: 13.2	Birds/ Shorebirds	Dunlin Dowitcher spp. Greater yellowlegs	Wilson's snipe Willet Killdeer
	Birds/ Waterfowl	Gadwall American Wigeon	Green-winged Teal
	Invertebrates		
Freshwater Marsh TOTAL: 52.8	Birds/ Waterfowl	Mallard Cinnamon teal Canada goose	Pied-billed grebe Ruddy duck Gadwall
	Birds/ Waterbirds	**California black rail** Virginia rail	Sora American bittern
	Birds/ Passerines	**Saltmarsh common yellowthroat** Red-winged blackbird	Marsh wren Song sparrow
	Amphibians	**California red-legged frog** Pacific tree frog	Bullfrog
	Reptiles	**Northwestern pond turtle**	
	Fish	Threespine stickleback	
Forested and Scrub Shrub Riparian TOTAL: 45.4	Mammals	**Southwestern river otter** **Dusk-footed woodrat**	black-tailed deer
	Birds/ Passerines	**Saltmarsh common yellowthroat** Warbling vireo Wilson's warbler	Swainson's Thrush Bewick's wren Purple finch
	Amphibians	**California red-legged frog**	**Pacific tree frog**
Mesic Coastal Scrub TOTAL: 12.4	Birds/ Passerines (resident and non-resident)	**Saltmarsh common yellowthroat** **Swainson's thrush**	Warbling vireo Wilson's warbler
Tidal Salt Marsh- High/ Upland Ecotone; Uplands TOTAL: 3.6	Mammals	Voles (refugia)	Shrews (refugia)
	Birds/ Waterbirds	**California black rail** (refugia)	**California clapper rail** (refugia)
	Birds/ Passerines	**Saltmarsh common yellowthroat** Savannah sparrow	Song sparrow Wrentit
Seasonally Flooded-Ponded Pasture-Grassland TOTAL: 1.8	Birds/ Waterfowl	Wood duck American wigeon Green-winged teal	Gadwall Common merganser
	Birds/ Waterbirds	Great egret	Great blue heron
	Amphibians	**California red-legged frog**	

Open Water habitat within the West Pasture is restricted primarily to relatively scattered unvegetated sections of creeks and isolated depressional features, some of which may be relicts of when the West Pasture was tidal. Because most of the creeks are relatively low gradient, Low or Tall Freshwater Marsh has established in most of the creek channels. Some intertidal mudflat occurs on the perimeter of creek channels during low tides, particularly on the northern end of Fish Hatchery Creek, but perennial creek flow, combined with the tidegate system, preclude Fish Hatchery Creek and other drainages from becoming fully intertidal.

Olema Marsh and Lower Bear Valley Creek. A similar gradient in habitats occurs at Olema Marsh and lower Bear Valley Creek (Figure 36). Conifer and mixed broadleaf evergreen forests or Woodland on the Inverness Ridge extend to the toe of the ridge, where a riparian thicket of largely Forested Riparian habitat has established due to groundwater and freshwater flow from several small drainages. This riparian thicket transitions downslope into the largest Freshwater Marsh in the Project Area, the Olema Marsh, approximately 39 acres in size. Ponding of water in this marsh is promoted by poor hydraulic connectivity of the marsh with

Lagunitas Creek (See Hydrologic Resources for more detailed discussion). Increasing water levels within recent decades appears to be killing some riparian trees closest to the marsh, leaving some dead trees as snags. Most of the marsh is dominated by tall emergents such as cattails, bulrush, rush (*Scirpus acutus*), although there are some Freshwater Marsh-Low areas dominated by floating or low-growing emergents such as water parsley. An earlier enhancement project during the 1980s that was undertaken by one of the property owners, Audubon Canyon Ranch, attempted to increase the amount of Open Water-Pond habitat through excavation, however, most of the created Open Water has slowly been recolonized by vegetation. A few willows have colonized spoil piles or berms left by excavation, creating some canopy diversity within the marsh. As with the West Pasture, the marsh also sharply transitions to upland on its eastern perimeter, but, rather than levee, the marsh is bordered by the natural shutter ridge that divides the Bear Valley and Olema Creek watersheds. The shutter ridge supports primarily a low-growing cover of native and weedy grasses and herbs within unmanaged or ruderal Pasture-Grassland habitat.

Because of the abrupt change in creek gradient within this portion of Bear Valley, the lower portion of Bear Valley Creek located directly upstream of Olema Marsh has also turned into a sizeable Freshwater Marsh with no defined channel. Several floodplain terraces of varying elevation on the western perimeter of the creek have expanded the diversity of riparian habitat types within this reach of the creek, creating riparian stands or Forested Riparian dominated by coast live oak and California bay, as well as by alder and several species of willow.

Giacomini Ranch – East Pasture. The habitat gradient within the East Pasture of the Giacomini Ranch differs slightly from that of the West Pasture and Olema Marsh (Figure 36). The East Pasture borders the town of Point Reyes Station, which is situated on Point Reyes Mesa, an elevated coastal marine terrace. Most of the Mesa has been developed, with the exception of GGNRA's Martinelli Ranch at the northern end of the East Pasture, which has retained a somewhat rolling hill topography dominated by Pasture-Grassland somewhat reminiscent of the coastal prairies that once covered a significant percentage of California's central coastline. The moderately steep slopes of the Mesa support either Coastal Scrub or Mesic Coastal Scrub vegetation communities. Groundwater springs and seep flow on portions of the Mesa have led to establishment of an unusually wet habitat for hillsides dominated by thickets of arroyo willow and coyote brush. One of the largest Mesic Coastal Scrub areas (~12.4 acres) occurs adjacent to Tomasini Creek on what is called the Point Reyes Mesa Bluff midway between the Giacomini Hunt Lodge and the Tomasini Creek tidegate. Coastal Scrub and Mesic Coastal Scrub habitats typically extend to the toe of the Mesa, where they transition either into highly or lightly managed Pasture-Grassland or creeks and ditches.

Many of the ditches and ditched sloughs within the East Pasture support Freshwater Marsh-Low habitat, although there are some stands of tall emergents – primarily cattails and bulrush – in some areas. The Giacominis have maintained some Non-Tidal Open Water-Channel habitats through frequent dredging of ditches and ditched sloughs to remove vegetation for water conveyance purposes. Muted Tidal Open Water-Intertidal habitat is largely precluded, even in Tomasini Creek, by levees, culverts, and tidegates that do not allow ditches or creeks to fully drain.

Several other freshwater and brackish marsh features occur in the East Pasture. The Old and New Duck Ponds are artificial depressional features that were constructed by the Giacominis for duck hunting. While both the East and West Pastures would appear to be relatively flat, both pastures slope downward towards the north, with the lowest elevations being in the northeastern corner opposite the large Mesic Coastal Scrub thicket on the Point Reyes Mesa Bluff. These low elevations, combined with episodic influxes of saltwater during high tides from a culvert on Tomasini Creek, have converted what was once probably a pasture into approximately 13.2 acres of seasonally flooded-ponded Muted Tidal Brackish Marsh-MudFlat/Panne habitat that floods extensively during winter and early spring. Following drawdown, salt-tolerant plant species stunted from prolonged inundation establish, although cover remains sparse. Muted Tidal Brackish Marsh with mid-sized emergent species such as alkali bulrush (*Scirpus maritimus*) has colonized deeper portions of a ditch immediately adjacent to the Tomasini Creek berm. Smaller marshes flooded for a shorter period during the winter occur in some of the ponds created by the Giacominis for duck hunting. The Old Duck Pond supports Freshwater Marsh habitat, while the New Duck Pond has developed into approximately 2 acres of Non-Tidal Open Water-Pond and Non-Tidal Brackish Marsh dominated by mid-sized emergent species such as spikerush (*Eleocharis macrostachya*) and alkali bulrush, probably because of the higher amount of residual salts in the soil.

Lagunitas Creek. Outboard of both the East and West Pastures, the levees are fringed by either Tidal Salt Marsh, Tidal Brackish Marsh, and, in the southern portion, Riparian Scrub-Shrub composed primarily of arroyo willow and Himalayan blackberry (*Rubus discolor*; Figure 36). The Tidal Salt Marsh and Tidal Brackish Marsh often occur as elevated “shelves” or as a fringe along the creek, which is Tidal Open Water- Channel habitat (Figure 36). Within the Project Area, Lagunitas Creek provides primarily two types of Open Water habitat. Downstream of White House Pool, the creek is shallow, and, during low tides, expansive flats composed of fine muds and coarse gravel and sands become exposed, creating Tidal Open Water-Channel/Intertidal habitat, although the deepest portions of the creek remain Tidal Open Water-Channel/Subtidal habitat. Upstream of White House Pool, the cattle crossing gravel bar has created a different mix of aquatic habitats through extensive ponding of creek waters. This long, flatwater pool extends to just south of the Green Bridge and is much deeper, remaining largely subtidal, except for the very edges of the creek, which become exposed during very low tides. Some distance upstream of the Green Bridge, the creek becomes more shallow again -- albeit more freshwater in nature than the section downstream of White House Pool -- and converts into more of a riffle, run, and pool structure characteristic of fluvial systems, although anthropogenic and cattle disturbance has probably impacted condition of these aquatic habitats to some degree.

North of the Giacomini Ranch, Lagunitas Creek continues to widen as it flows toward Tomales Bay. On its western and eastern perimeter, the creek is bordered by undiked Tidal Salt Marsh. The transition between creek and marshplain is abrupt, with sediment deposition during storms creating relatively high alluvial or natural levees along the creek perimeter. These Tidal Salt Marsh-High/Upland Ecotone habitats subtly grade into the Mid- and High- Tidal Salt Marsh, which extend for some distance northwards towards Tomales Bay. Low elevation Tidal Salt Marsh or Tidal Salt Marsh-Low is restricted to fringes along tidal creeks within the Tidal Salt Marsh, although expansive patches have colonized intertidal mudflats at the very northern edge of the Lagunitas Creek delta. Fringing marsh along the perimeter of Tomales Bay between Inverness Park and Inverness shows a slightly different habitat structure, with Tidal Open Water-Channel/ Subtidal and Intertidal habitats of Fish Hatchery Creek and the Bay transitioning from low elevation Tidal Salt Marsh through Mid- to High Tidal Salt Marsh before abruptly converting to Tidal Salt Marsh-High/Upland Ecotone, Freshwater Marsh, or Riparian Forest or Scrub-Shrub habitat at the toe of the Inverness Ridge.

Fish and Wildlife Habitats of Special Significance

While all habitats are important, some habitats are considered particularly important, because they are considered key to saving the threatened and endangered species that use them. These habitats have received special protection or attention through federal and state regulations or local ordinances. A number of these habitats and the regulatory mechanisms in place for protecting them have been discussed earlier under Vegetation Resources. These include:

- ***Wetlands***. Because of their critical role in improving water quality for both humans and wildlife, waters and special aquatic sites such as wetlands are protected through Section 404 and Section 401 of the Clean Water Act and California’s Porter-Cologne Act. Wetlands are also protected through California’s Coastal Act and CDFG’s Streambed Alteration Agreement. Wetlands are protected under the California Coastal Act for the benefit of “marine organisms” and “human health,” and CDFG manages lakes, rivers, and streambeds for the protection of fish, wildlife, and native plant resources. For more information on acreage of wetlands, see Vegetation Resources.

- ***Riparian Areas***. In addition to protection of riparian habitat that qualifies as “wetland” according to federal and state regulatory agencies, riparian habitat is also protected by other state and local regulations and policies. CDFG regulates activities river- and streamside riparian habitat through Streambed Alteration Agreements, and the County of Marin has established a Streamside Conservation Area or stream setback that is superseded in the California Coastal Commission’s Coastal Zone by specific policies under the Local Coastal Plan (LCP) that protects riparian habitat. In certain areas, specific riparian habitat is protected: the Point Reyes Station Community Plan has identified preservation of the riparian habitat on the Point Reyes Mesa bluff as a specific objective.

- ***CNDDB Special Habitats or Natural Communities***. CDFG has designated certain habitats or Natural Communities as deserving of protection, although they are afforded less protection than special status species. This designation invokes a broad-based ecosystem approach to planning for the protection and perpetuation of biological diversity or multiple special status species. In the Project Area, two special habitats have been identified as potentially occurring – Coastal and Valley Freshwater Marsh and Northern Coastal Salt Marsh. Northern Coastal Salt Marsh would include the undiked marsh to the north of the Giacomini Ranch, as well as the fringe marsh adjacent to Sir Francis Drake Boulevard extending from the Ranch to Inverness. There are two areas that may potentially qualify as Coastal Freshwater Marsh – the West Pasture freshwater marsh and Olema Marsh – but neither would appear to completely meet the qualifications.

Critical Habitat

When the federal government lists a species as endangered or threatened, it is also supposed to identify that species' critical habitat. Critical Habitat includes those areas that are important for the species' survival or recovery and that need special management. While a designated critical habitat area is not intended to include the entire potential habitat of the species, it can include habitat that is not currently occupied by the species. The federal government does not consider economic impacts when it "lists" a species, but it does consider economics when deciding what areas should be designated as critical habitat. The agency is required to use the best available scientific information in making a decision about critical habitat. Only about 12 percent of listed species have a designated critical habitat area.

The Project Area incorporates Critical Habitat area for the federally endangered central California coast coho salmon (*Oncorhynchus kisutch*) and threatened central California coast steelhead (*Oncorhynchus mykiss*). Initially, it used to include Critical Habitat for the California red-legged frog (*Rana aurora draytonii*), but boundaries were adjusted during a recent reproposal of the Critical Habitat listing for this species, and the Marin Units 1 and 2 are currently located some distance east and west of the Project Area, respectively. Marin Unit 2 includes the Drakes Estero and Limantour Estero watersheds on the western portion of the Point Reyes Peninsula, and the boundary line is at least 1 mile or more from the Project Area. Marin Unit 1 appears to include principally the Walker and Chileno valleys northeast of Point Reyes Station. Critical Habitat has been designated for three other species that occur in the Project Area, but those listings are either for different “evolutionary significant units” of the same species (chinook salmon) in other states or different populations within the same state (San Diego and Orange county populations of tidewater goby; *Eucyclogobius newberryi*; FE).

Central California Coast Coho Salmon Critical Habitat. Critical Habitat for the federally endangered central California coast coho salmon population is designated to include all river reaches accessible to listed coho salmon from Punta Gorda in northern California south to the San Lorenzo River in central California, including Mill Valley (Arroyo Corte Madera Del Presidio) and Corte Madera Creeks, tributaries to San Francisco Bay. Excluded are areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 4,152 square miles in California. The following counties lie partially or wholly within these basins: Lake, Marin, Mendocino, San Mateo, Santa Clara, Santa Cruz, and Sonoma.

Central Coast Steelhead Salmon Critical Habitat. Critical Habitat for the federally threatened central coast steelhead salmon population is designated to include all river reaches and estuarine areas accessible to listed steelhead in coastal river basins from the Russian River to Aptos Creek, California (inclusive), and the drainages of San Francisco and San Pablo Bays. Also included are all waters of San Pablo Bay westward of the Carquinez Bridge and all waters of San Francisco Bay from San Pablo Bay to the Golden Gate Bridge. Excluded is the Sacramento-San Joaquin River Basin of the California Central Valley as well as areas above specific dams or long-standing, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). In Tomales and Drakes Bays, Critical Habitat does not include areas upstream of Peters Dam, Seeger Dam, and Soulejule Dam.

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act is the governing authority for all fishery management activities that occur in federal waters within the United States 200 nautical mile limit, or Exclusive Economic Zone (EEZ). Originally passed and signed into law in 1976, the Magnuson Act, as it was then called, established the U.S. 200 nautical mile limit and by implication legitimized a 200 nautical mile EEZ for all other maritime nations. One of the potentially applicable components of this act to non-oceanic activities is that it requirement conservation and enhancement of Essential Fish Habitat (EFH). Both marine and freshwater EFH designations can be made. Defined by Congress as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity," the designation and conservation of Essential Fish Habitat seeks to minimize adverse effects on habitat caused by fishing and non-fishing activities. Non-fishing activities that can affect EFH include dredging and filling. The EFH descriptions and identifications for the Pacific's FMPs were approved on: September 27, 2000, for west coast salmon fisheries. The regulated EFH species in Tomales Bay is coho salmon, which occurs in Lagunitas Creek. Freshwater EFH includes Tomales Bay to the upper portions of its watershed, while the entire outer coastline of Point Reyes has been designated marine EFH.

General Fish and Wildlife Use

Regional and Tomales Bay Setting

As described earlier, the incredible diversity of wildlife attracted to this region by its diversity and complexity of habitats has gained Point Reyes and Tomales Bay international recognition. The Continental Shelf present offshore hosts not only hundreds of resident organisms, but numerous migratory and transient visitors who come to feast on its resources and breed and rear young in its relatively sheltered environs. Coastal upwelling or turnover of nutrients from deeper marine waters due to strong winds dramatically boosts primary productivity within nearshore waters (Smith and Hollibaugh 1998). The California coast is one of just five major coastal upwelling regions in the world, and while coastal upwelling areas make up only one-tenth of a percent of the ocean's surface area, they account for 95 percent of the global marine biomass and more than 21 percent of the world's fisheries landings (MBARI 2002). Hundreds of invertebrate species take advantage of bountiful resources in submerged rocky and sandy habitats. Plentiful invertebrates and large kelp forests sustain thriving fisheries, including commercial species such as rockfish and Pacific herring. Marine seabirds come seasonally in large numbers to the outer coast and Farallones to breed and nest. In addition, every winter, more than 30 percent of the world's cetacean mammals swim by the coast of Point Reyes, as whales move annually from calving grounds in Baja California to the artic water. Harbor seals and northern elephant seals also come in winter to haul-out and pup, taking advantage of the benign environment and rich food resources.

Many of these marine species find additional foraging, protection, and even nursery habitat in the shallows of Tomales Bay. The Park Service recently initiated a project with several local partners to document the biodiversity of Tomales Bay. By fall 2004, the Tomales Bay Biodiversity Inventory (TBBI) had documented more than 2,000 species in the intertidal and subtidal portions of the Bay, including 28 species of Protozoa, 9 species of Fungi, 262 species of Mollusks, 270 species of Arthopods, 252 species of Annelid Worms, and 419 species of Chordates, which includes mammals and more than 40 species of fish (TBWC 2002; Seashore 2005). The incredible diversity in submerged, intertidal, and upland habitats attracts species that move in and out of the estuary, as well as estuarine species that spend their entire lives within its boundaries. During summer and early fall, many marine fish species, as well as skates, rays, and sharks, move into the Bay to forage on populations of estuarine organisms, many of which are peaking in abundance during this period (TBWC 2002). Non-resident fish species that use Tomales Bay include coho salmon, steelhead, sardines, ling cod (*Ophiodon elongatus*), Pacific herring, northern anchovy (*Engraulis mordax*), and marine surfperch species such as walleye surfperch (*Hyperprosopon argenteum*; Bratovich and Kelley 1995, TBA 1995 *in* TBWC 2002; Pettigrew 2004). Sandier portions of the Bay draw bottom-dwelling fish such as California halibut (Evens 1993). Even marine mammals such as harbor seals and sea lions (*Eumetopias jubatus*) venture into the estuary to feed on herring and other marine species. Harbor seals often haul out and rest on tidal sand bars and sandy beaches within the outer Bay such as Hog Island and Tom's Point, using some areas for pupping (Allen and King 1992). Sea lions feed in the Bay during December and January when the herring and salmon are running (ARA 2002).

The food web within Tomales Bay is also supported by primary producers such as phytoplankton (Spratt 1989), as well as eelgrass. The large eelgrass beds in Tomales Bay provide foraging and nursery habitat, as well as refugia or protection from predators for many species of invertebrates, fish, birds, and mammals (TBWC 2002). Many invertebrates, fish, and even some waterfowl forage in or on eelgrass, including juvenile Dungeness crab (*Cancer magister*), some flatfish species, and bat rays. Pacific herring, which often number as many as 50 million during spawning periods, uses eelgrass and algae such as *Gracilaria* for its eggs (Moore and Mello 1995)*in* TBWC 2002), and least terns (*Sterna antillarum*) and other species such as loons (Gaviiformes); grebes (Podicipediformes), and cormorants (*Phalacrocorax auritus*; CSC) forage on these and other small fish (Palmer 1962) *in* TBWC 2002). Many waterbird species such as surf scoters (*Melanitta perspicillata*), bufflehead (*Bucephala albeola*), scaup, goldeneyes, and black brant (*Branta bernicla*) consume herring roe or eggs (Hardwick 1973; Bayer 1980; Briggs et al. 1987; TBWC 2002) or, in the case of brant, eelgrass itself (Goals Project 1999).

Along with its larger neighbor to the east, Tomales Bay is an important stop on the Pacific Flyway for migratory and overwintering waterfowl and shorebirds. Thirteen years of surveys have recorded approximately 163 waterfowl and shorebird species within the Bay, with 122 of those occurring regularly or at least occasionally (Kelly 2003). During the fall and winter, the Bay supports on average approximately 25,000 waterfowl, tens of thousands of gulls, and 20,000 shorebirds, with the latter statistic earning it a designation as one of 16 Wetlands of Regional Importance by the Western Hemisphere Shorebird Reserve Network (Kelly and Tappen 1998; Kelly 2001). During spring, Marin hosts as many as 150 species of breeding birds, most of which are on the coast (ARA 2002). Tomales Bay cannot compete with San Francisco Bay in terms of sheer numbers, but Tomales Bay supports higher densities of many species (J. Kelly, ACR, pers. comm.) and accounts for a large proportion of many species' statewide population numbers. Tomales Bay represents roughly 30.8, 12.3, and 6.4 percent of the state's total population of black brant, bufflehead, and scoters, respectively (Kelly and Tappen 1998). Tomales Bay is one of only three sites along the Pacific Flyway that support more than 100 red knots (*Calidris canutus*) during spring migration (C. Hickey, PRBO, *pers. comm.*). Ten of the 17 Partners-in-Flight Riparian Focal Species breed in the Point Reyes region (C. Hickey, PRBO, *pers. comm.*), and it may support one-third of the total population of neotropical migrant species such as saltmarsh common yellowthroat (*Geothlypis trichas* var. *sinuosa*; former FSC, CSC; ARA 2002). Many species move from Tomales Bay to San Francisco Bay or vice versa during migration, including dunlin (*Calidris alpina*; (Warnock et al. 1995) and canvasback (*Aythya valisineria*), greater scaup (*Aythya marila*), and surf scoter (Takekawa et al. *in press*). A large factor in the avian diversity found in Point Reyes comes from rare or extremely rare species, which account for 50 percent of total species observed (Evens 1993).

Tidal Salt Marsh is occasionally used by wading birds and long-legged shorebirds for roosting or foraging, but more commonly by rails such as California clapper rails (*Rallus longirostris obsoletus*; FE, SE), California black rail (*Laterallus jamaicensis coturniculus*; ST), Virginia rails (*Rallus limicola*), and sora (*Porzana carolina*) that remain within intertidal marshes and small channels, where they forage on invertebrates in the mud. Many songbirds are incidental or occasional visitors to Tidal Salt Marsh, including the saltmarsh common yellowthroat. Southwestern river otters (*Lontra canadensis sonorae*; CSC) forage along tidal creeks on macroinvertebrates, building burrows in adjacent Upland Ecotone or riparian habitat. Resident estuarine fish in Tomales Bay include threespine stickleback (*Gasterosteus aculeatus aculeatus*), arrow goby (*Clevelandia ios*), Pacific staghorn sculpin (*Leptocottus armatus*), shiner surfperch (*Cymatogaster aggregata*), bay pipefish (*Syngnathus leptorhynchus*), and non-native species such as yellowfin goby (*Acanthogobius flavimanus*; TBWC 2002, (Pettigrew 2004), with composition sometimes dependent on tidal cycle. Some fish move up onto marshplains during extreme high tides to forage on benthic and epibenthic invertebrates. Northern harriers (*Circus cyaneus*; CSC), White-tailed kites (*Elanus caerulus*), and osprey (*Pandion haliaetus*; CSC) hunt rails and other species in Tidal Salt Marshes, including rodents living in drier portions of wetlands and ecotones.

During extreme high tides or storm events, many avian and mammal species such as rails, rodents, and otters find refuge in uplands bordering the estuary. The steep slopes of the Inverness Ridge, as well as the lower-elevation coastal marine terraces on the east, not only offer refugia and foraging habitat during extreme events, but, of course, habitat for a diversity of terrestrial invertebrates, amphibians, reptiles, birds, and mammals. Some of the most important, unique, or charismatic of these species include the northern spotted owl (*Strix occidentalis caurina*; FT), Point Reyes mountain beaver (*Aplodontia rufa phaea*; former FSC), tule elk (*Cervus elaphus nannodes*), bobcat (*Felis rufus*), and mountain lion (*Puma concolor*).

Habitat diversity within estuaries occurs not only through vertical variability in topography or bathymetry, but through horizontal or longitudinal variability in salinity. Shifts in salinity regime are linked to shifts in wildlife species assemblages and changes in the diversity and type of species, although some species seem to move with ease between regimes. Because of physiological tolerances, many species are restricted to specific salinity regimes, such as the California freshwater shrimp (*Syncaris pacifica*), California red-legged frog, tidewater goby, and northwestern pond turtle. For other species, salinity tolerance shifts between life stages. Marine species such as coho salmon, steelhead, and other anadromous fish use freshwater environments in the upper portions of watersheds for spawning and rearing of young, with the young eventually moving back out to sea. Salmon use brackish areas only as transitional habitat for foraging, resting, or refugia during upstream or downstream migration or during the process of converting from freshwater to saltwater. Other marine species such as California halibut, flounder, and Pacific herring use brackish environments within the estuary as nurseries for young, which return to the sea as adults.

One of the most productive habitats within many estuaries is the estuarine transition zone. Within open water areas of estuaries such as San Francisco Bay, certain invertebrates and fish occur preferentially in the Low Salinity Zone (LSZ) or X2, where salinity approximates 2 psu or ppt (discussed under Water Resources –

Water Quality). Significant relationships between X2 and abundance have been found, at least some of the time, for estuarine-dependent copepods, mysids, bay shrimp (*Crangon franciscorum*), and several fish including Pacific herring and starry flounder (Kimmerer 2004). Within Tomales Bay, the Lagunitas and Walker Creek deltas probably represent the largest estuarine transition zones. Conversely, some invertebrate species appear to prefer hypersaline conditions, which occur during the late summer in the innermost portions of Tomales Bay. Discrete populations of closely related species of the copepod genus *Acartia* have apparently been observed in portions of Tomales Bay during hypersaline periods (Kimmerer 1993). Even estuarine circulation patterns can affect species diversity or viability, with the strength of gravitational or classic estuarine circulation linked in San Francisco Bay to successful recruitment for Bay shrimp and starry flounder and movement of mysid, longfin smelt, and striped bass (Kimmerer 2004).

Fish and Wildlife Species Resources Within the Project Area

While moderate to intensive development and management of the Giacomini Ranch and Olema Marsh may have caused wildlife resources to decline relative to historic conditions, the Project Area nonetheless supports a diverse array of animal species, a large proportion of which are special status because their populations are considered at risk (ARA 2002). During the course of baseline wildlife surveys, at least six reptiles, four amphibian, 32 fish, and 194 bird species were observed in the Project Area. Of the 194 bird species, 49 percent were year-round residents, a pattern that mirrors the region in general (ARA 2002). More specific information on special status species is provided below, and a list summarizing some of the species present can be found in Table 17. While many species are resident to the Project Area or vicinity, numerous others are transients, including even some marine species, that primarily use Tomales Bay, but occasionally frequent the Project Area as a supplement to the more extensive habitats in the Bay itself such as Tidal Open Water-Channel Subtidal and Intertidal habitats (ARA 2002). Sea lions have even been known to occasionally wander as far south as the Project Area (ARA 2002).

Many of the species observed in the Project Area rely upon the complex mosaic of wildlife habitats present. For example, 75 percent of the avian species observed during winter surveys were not restricted to just one habitat, but were utilizing a combination of riparian, marsh, and open water habitats (ARA 2002). The most rare species such as salt marsh common yellowthroat, California black rail, sora, and yellow rail (*Coturnicops noveboracensis*), often moved between Tidal Salt Marsh, Freshwater Marsh, Forested and Scrub Shrub Riparian, and shallowly flooded- ponded Pasture-Grasslands (ARA 2002). This habitat interdependence extended to species other than avian ones. While California red-legged frog breeds and rears in the West Pasture freshwater marsh, during the summer, most frogs may have moved into riparian areas and forested hillsides to the west or possibly into the pastures (Fellers and Guscio 2002; G. Fellers, USGS, *pers. comm*.).

In general, most of this habitat diversity occurs on the perimeter or "edge" of the Giacomini Ranch and, to some extent, Olema Marsh. Within the Giacomini Ranch, the perimeter or edge represents not only the dynamic interface between groundwater, freshwater, and, to some extent, saltwater, but is also less heavily managed for agricultural purposes. In addition, it offers proximity of some very different types of habitat such as coniferous forest or Woodland and Coastal Scrub to the Project Area also act to promote the diversity of wildlife species observed (ARA 2002).

Giacomini Ranch – East Pasture. While both diked pastures are grazed by cattle, the East Pasture differs from the West in that it is more heavily managed through grazing, mowing, ditch dredging, irrigation, and manure spreading and is almost completely disconnected from tidal influence, both of which affect the potential to support wildlife. Diking, perhaps not surprisingly, seemingly impacts aquatic communities more than others. Most of the drainage ditches and diked tidal sloughs within West and East Pastures had very low numbers and diversity of benthic, epibenthic, and macro- invertebrates (NPS, unpub. data). Permanent impoundment of waters does not allow ditches and creeks to become oxygenated through regular exposure, so the muds are very anoxic and support few species, including one species of gastropod (snails) and non-native crayfish, the latter of which may have been introduced by the Giacominis. Numbers and diversity of fish also remained low within Giacomini Ranch waterways, a large percentage of which are hydrologically disconnected from both upstream and downstream water bodies (NPS, unpub. data). Three-spine stickleback and mosquitofish (*Gambusia affinis*), along with, in lesser numbers, goby larvae and longjaw mudsucker (*Gillichthys mirabilis*), were the only fish observed in the drainage ditches and ditched sloughs in the East Pasture, with threespine stickleback representing the principal species observed in Tidal, Muted Tidal, and Non-Tidal waters within the Project Area (NPS, unpub. data, ARA 2002). The lack of hydrologic connectivity, combined with frequent hypoxia or low oxygen conditions potentially caused by ditch dredging, minimizes the number of species that can establish and live in these habitats.

Despite low numbers of invertebrates and fish, ditched waterways provided aquatic and basking habitat for northwestern pond turtles, which were seen “regularly” in the East Pasture (Fellers and Guscio 2002). A few adult California red-legged frogs occurred in the East Pasture, although they were not believed to be breeding adults, and no juveniles were observed (Fellers and Guscio 2002).

Bullfrogs (*Rana catesbeiana*), believed to be one of the primary predators of red-legged frog, have been observed in Tomasini Creek and some East Pasture ditches (Fellers and Guscio 2002). Pastures provide habitat for small rodents such as voles (*Microtus*), gophers (*Thomomys*), and shrews (*Sorex*; ARA 2002). Southwestern river otters (*Lontra canadensis sonorae*; CSC) occasionally swim in drainage ditches near Lagunitas Creek, and, infrequently, red fox (*Vulpes vulpes*) use some of the discarded irrigation pipes in the Pastures, as well as visit the Dairy Facility (L. Parsons, *pers. obs*., J. Evens, *pers. obs*.). Black-tailed deer (*Odocoileus hemionus columbianus*) also move down regularly from the Point Reyes Mesa Bluff to graze in pastures.

Avian use of the pastures in the East Pasture was seasonally variable. The northern portion of the pasture themselves frequently hosted roosting Canada geese (*Branta canadensis*), great blue herons (*Ardea herodias*; S4), great egrets (*Ardea alba*; S4), and, occasionally, waterfowl species such as mallards (*Anas platyrhynchos*). Virginia rails and sora established territories in 2001-2002 in one of the ditched sloughs (ARA 2002). In general, ditches supported a low diversity of species that include occasional use by mallards, gadwall (*Anas strepera*), lesser scaup (*Aythya affinis*), eared grebe (*Podiceps nigricollis*), black phoebe (*Sayornis nigricans*), and even belted kingfisher (*Ceryle alcyon*; ARA 2002). Raptors hunt over the East and West Pastures, probably searching for small mammals and unwary birds. However, in general, managed pastures “are relatively depauperate in terms of supporting breeding birds in general and special status species in particular” (ARA 2002). Savannah sparrows (*Passerculus sandwichensis*) did attempt to nest in some of the managed pastures, however, some of the fields were mowed during the height of nesting effort, thus excluding perhaps a third of their population (ARA 2002). The only avian species using managed pastures as its primary habitat was grasshopper sparrow (*Ammodramus savannarum*; former FSC, S2), but it arrived late and did not breed (ARA 2002). Large flocks of migratory swallows sometimes forage low over pastures and marshes, especially early and late in the day (ARA 2002).

Several areas in the East Pasture supported at least seasonally higher avian densities. Waterfowl species such as mallards often use drainage ditches and ditched sloughs in low numbers. Buffleheads regularly use some of the old Duck Ponds created by the Giacominis (ARA 2002). The greatest waterfowl and shorebird use in the East Pastures occurs in what is known as the shallow shorebird area in the northeast corner of the East Pasture, a unique habitat within the Project Area. This Muted Tidal Brackish Marsh-Flat / Panne floods from December through April – although in years with early rainfall, it can be early as October -- with surface runoff, precipitation, and tidal waters that flow into the East Pasture from a culvert in the levee of the Tomasini Creek berm, creating brackish water conditions. Many waterfowl species, especially dabbling ducks such as gadwall, wigeon, and teal, are attracted to this area in the winter (ARA 2002). Shorebirds also gather here in rather high numbers to roost and forage when adjacent tidal flats are inundated at high tide (ARA 2002). Some of the most common shorebird species included dunlin, dowitcher species (*Limnodromus sp*.), greater yellowlegs (*Tringa melanoleuca*), common snipe (*Gallinago gallinago*), willet, and killdeer (J. Kelly, ACR, *pers. comm*.).

TABLE 17. PRESENCE OF GENERAL WILDLIFE GROUPS, CLASS, OR ORDERS AND REPRESENTATIVE TAXA AND/OR SPECIES WITHIN SPECIFIC UNITS OF THE PROJECT AREA

Note: E: East Pasture; TC: Tomasini Creek; W: West Pasture; L: Lagunitas Creek; and O: Olema Marsh

General Groups, Class, or Orders	Representative Taxa or Species	EP	TC	WP	LC	OM
FISH						
Native Estuarine Fish-Resident	threespine stickleback, arrow goby, longjaw mudsucker, staghorn sculpin, prickly sculpin, **Tidewater goby, Tomales roach**	√	√ **TG**	√ **TG**	√ **TR**	√
Non-Resident Native Fish	Salmonids		√	√	√	***?***
	Starry flounder, topsmelt				√	
Non-Native Fish-Resident	Mosquitofish	√		√		
	yellowfin goby				√	
INVERTEBRATES						
Epibenthic Invertebrates	Gammarid amphipods		√	√	√	
Pelagic Invertebrates - Native	Mysid shrimp		√		√	
Pelagic Invertebrates – Non-native	Korean shrimp		√	√	√	
Benthic Invertebrates - Bivalves			√		√	
Macroinvertebrates - Native	Western shorecrab					
Macroinvertebrates – Non-Native	Green crab		√		√	
	crayfish	√		√		
AMPHIBIANS AND REPTILES						
Amphibians - Native	**California red-legged frog**	√	√	√		√
	Pacific tree frog	√	√	√	√	√
Amphibians – Non-Native	Bullfrog	√	√			√
Reptiles	**Northwestern pond turtle**	√	√	√	√	√
BIRDS						
Diving Ducks	Greater and lesser scaup, canvasback, buffleheads, ruddy	√			√	√
Dabbling Ducks	Mallards, gadwall, wigeon, teal, northern shoveler, wood ducks	√	√	√	√	√
Waterbirds	Cormorant, Virginia rails, sora, eared grebe, belted kingfisher, **California black rail, California clapper rail**			√ **BR**	√ **BR CR**	
Colonial Nesting Waterbirds	Herons, egrets,	√		√		
Shorebirds – Deep Probers	Dowitcher, greater yellowlegs, common snipe, willet	√		√		
Shorebirds – Shallow Probers	Dunlin, spotted sandpiper	√		√	√	
Passerines – Riparian/ Neotropical migrants	Swainson's thrush, warbling vireo, Wilson's warbler	√	√	√	√	√
Passerines –Riparian/ Resident	**Saltmarsh common yellowthroat**, Bewick's wren	√	√ **YT**	√ **YT**	√	√ **YT**
Passerines - Marsh	Marsh wren, red-winged blackbird, **Saltmarsh common yellowthroat**	√		√	√	√
Passerines - Grassland	Savannah sparrow, grasshopper sparrow, Western Meadowlark	√		√		
Raptors	Osprey, **American peregrine falcon**, White-tailed kite	√		√	√	?
Non-Native Birds	Turkeys, European starlings	√		√		
MAMMALS						
Small ground-dwelling mammals	Voles, gophers, shrews	√	√	√	√	
Bats		√	√	√	√	√
	Southwestern river otter	√	√	√	√	?
	Red fox	√		√		
	Black-tailed deer	√	√	√		

Giacomini Ranch – Tomasini Creek. A greater diversity and number of wildlife occurred in creeks and portions of pastures that had at least muted tidal influence. Tomasini Creek's malfunctioning tidegate allows the full upper range of high tides, but attenuates low tides, creating permanent Muted Tidal Open Water-Channel/Subtidal habitat rather than the Muted Tidal Open Water-Channel/Intertidal habitat that would probably exist were the tidegate removed.

Perhaps, the largest benefit of increasing tidal influence and hydrologic connectivity comes from the associated increase in aquatic organisms. Benthic invertebrates still occurred only in low densities, probably because the tidegates and associated structures act to impound waters even during low tides, decreasing Muted Tidal Open Water-Channel/Intertidal habitat and increasing soil anoxia (NPS, unpub. data). The number of epibenthic organisms increased slightly, with Tomasini Creek supporting the non-native brackish water shrimp (*Palaemon macrodactylus*) and native mysid shrimp (*Neomysis mercedis*), an important prey item for salmon (Bratovich and Kelley 1988), along with smaller epibenthic invertebrates such as amphipods, isopods, and insects. The invasive non-native crustacean, green crab (*Carcinus maenas*), may also occur in Tomasini Creek.

Muted tidal influence also increased fish species diversity slightly compared to the East Pasture. Fish in Tomasini Creek included staghorn sculpin (*Gymnocanthus tricuspis*) and prickly sculpin (*Cottus asper*), as well as threespine stickleback and longjaw mudsucker. Starting in 2002, the federally endangered species, tidewater goby, has been observed annually in relatively low numbers in a section of Tomasini Creek from the Giacomini Hunt Lodge to the midpoint of the Point Reyes Mesa bluff. In addition, federally endangered juvenile central coast coho salmon and *Oncorhynchus mykiss* juveniles -- assumed for regulatory purposes to be steelhead -- were found in small numbers in June 2005 in Tomasini Creek (NPS, unpub. data). One steelhead was also observed in 2004 (D. Fong, GGNRA, *pers. comm*.). Any historic runs of steelhead or coho salmon in Tomasini Creek may have been negatively affected by repeated diversions of Tomasini Creek through different parts of the East Pasture (see Water Resources), leveeing of the creek, dredging, and installation one-way tidegates. Furthermore, summer rearing habitat for salmon and steelhead juveniles in upper portions of the watershed may be limited by draw-down of Tomasini Creek in the late summer and early fall during average and dry rainfall years and water quality impacts from operation of the now-closed West Marin Landfill. The increased diversity of aquatic organisms also draws other species, as well, including common North American raccoons (*Procyon lotor*) and southwestern river otter (J. Evens, ARA, *pers. comm*.).

While the western leveed portion of Tomasini Creek does not support much riparian vegetation, the eastern bank has a well-developed riparian corridor that transitions into the expansive and unique Mesic Coastal Scrub habitat that extends across the face of the Point Reyes Mesa bluff. The combination of riparian and coastal scrub habitats attracted about 4 percent of the breeding birds observed in the Project Area during spring, including species such as Swainson's thrush (*Catharus ustulatus oedicus*, CSC), Bewick's wren (*Thryomanes bewickii*; CSC), Wilson's warbler (*Wilsonia pusilla*), Warbling vireo (*Vireo gilvus*), and Allen's hummingbird (*Selasphorous sasin*, CSC; ARA 2002). Winter use of these habitats was slightly higher, with almost 10 percent of the birds observed during winter occurring here (ARA 2002). Saltmarsh common yellowthroat occurred upstream near the Giacomini Hunt Lodge and north of Mesa Road (ARA 2002). Greater yellowlegs and dabbling ducks sometimes use the creek itself (J. Evens, ARA, *pers. comm*.).

Giacomini Ranch –Fish Hatchery Creek and West Pasture. As with Tomasini Creek, muted tidal influence and better hydrologic connectivity with upstream portions of Fish Hatchery Creek watershed appear to increase wildlife diversity in the West Pasture relative to the East, even though it is diked. In addition, pastures in the West Pasture are not as highly managed as the East Pasture, with only annual mowing, occasional creek dredging, and creek flow regulation via tidegates occurring. Grazing pressure is also reduced relative to the East Pasture. As with Tomasini Creek, tidegates do not allow waters to fully drain, thereby retaining largely Muted Tidal Open Water-Channel/Subtidal habitats within creeks and ditched sloughs, although there are some fringes of Muted Tidal Open Water-Channel/Intertidal habitat on the creek perimeter.

Fish assemblages within the West Pasture were very similar to the East, with threespine stickleback and mosquitofish the most common species, although sculpin and arrow goby were also present (NPS, unpub. data, ARA 2002). The number of epibenthic organisms also increased slightly, primarily through occurrence of smaller invertebrates such as amphipods, isopods, and insects. While water quality conditions are generally better in West Pasture drainageways than in the East, fish kills of highly tolerant species such as threespine stickleback occurred occasionally in the West Pasture freshwater marsh, perhaps because elevated primary productivity during the day causes oxygen depletion at night. *Oncorhynchus mykiss* juveniles, assumed for regulatory purposes to be steelhead, were observed in very low numbers (one individual) in Fish Hatchery Creek in both 2001 and 2005 (NPS, unpub. data; ARA 2002). Historic accounts depict a thriving steelhead run on this creek, with a very rough estimate of 10,000 "young" (< 3 inches) in 1899 (Schofield 1899) *in* ARA 2002). Interestingly, despite its name, this subwatershed probably has never supported a "fish hatchery" operation (B. Ketcham, Seashore, *pers. comm*.). In addition, in late 2005, Seashore biologists found five individuals of what has been preliminarily identified as tidewater goby in the West Pasture Old Slough, a tributary to Fish Hatchery Creek.

Northwestern pond turtle appears to occur in lower numbers in the more saline West Pasture than in the East, with only one reported sighting in 2001-2002 (Fellers and Guscio 2002). Conversely, the West Pasture supports the largest population of breeding adult and juvenile California red-legged frogs in the Giacomini Ranch, with frogs primarily utilizing the West Pasture freshwater marsh habitat and adjacent portions of Fish Hatchery Creek (Fellers and Guscio 2002). In 2001-2002, adult frogs totaled as high as 21 (Fellers and Guscio 2002). In 2003, the already malfunctioning tidegate on Fish Hatchery Creek collapsed, increasing the amount of tidal flow. This increase in tidal flow expanded the degree of salinity intrusion into the marsh and appeared to cause a decrease in frog use (G. Fellers, USGS, pers. comm.). While tidal influence was reduced after tidegate repair in fall 2003, salinity intrusion still appears to be occurring. Since 2003, numbers of frogs have not been as high, although 12 adults and one egg mass were found in January 2006 (G. Fellers and P. Kleeman, unpub. data). Predation pressure on this population may come primarily from native predators such as black-crowned night heron (*Nyctiorax nyctiorax*) rather than bullfrogs, which were detected for only the first time in this marsh in 2006 (Fellers and Guscio 2002; P. Kleeman, USGS, *pers. comm*.). A more detailed discussion of the California red-legged frog occurs later in this section.

Southwestern river otter regularly use the levee near the Fish Hatchery Creek tidegate, apparently foraging on crustaceans such as the invasive, non-native green crab. Several otter burrows have been built in the Forested Riparian habitat adjacent to Sir Francis Drake Boulevard at the West Pasture north levee (ARA 2002). Black-tailed deer occasionally graze in the West Pasture Freshwater Marsh, and non-native wild turkeys (*Meleagris gallopavo*) have commonly been observed using Meadows and Pasture-Grassland in the West Pasture, as well.

As with the East Pasture, herons, egrets, and Canada geese occasionally roost in seasonally flooded-ponded or temporarily flooded Meadows and Pasture-Grassland, and waterfowl sporadically use Fish Hatchery Creek and the West Pasture Old Slough. Marsh wrens *(Cistothorus palustris)* frequent stands of cattails and bulrush in Fish Hatchery and the West Pasture Old Slough. Virginia rails established territories along Fish Hatchery Creek, however, sections of creek with shorter vegetation tended to support primarily song sparrows (*Melospiza melodia*; ARA 2002; J. Evens, ARA, *pers. comm*.). American goldfinch (*Carduelis tristis*) and house sparrow (*Passer domesticus*) flocks occasionally use large patches of tall weeds on the levees such as poison hemlock (*Conium maculatum*). However, the habitat with the highest value to breeding birds was the West Pasture Freshwater Marsh-Forested Riparian association in the northwestern corner of the property (ARA 2002). Saltmarsh common yellowthroat, Virginia rail, song sparrow, marsh wren, blackbird (*Euphagus cyanocephalus)*, and other marsh-riparian associates commonly occur in the marsh and the riparian corridor adjacent to Sir Francis Drake Boulevard. Use of the Freshwater Marsh-Forested Riparian was also high during the autumn and winter, with 40 to 50 percent of all species observed during autumn occurring in riparian-marsh or riparian-ruderal field associations in the northwestern and southwestern corners of the Project Area, respectively (ARA 2002). In addition to these “permanent habitats,” waterfowl often congregate in large numbers in the southern portion of the West Pasture in seasonally flooded-ponded Meadows and Pastures that receive significant freshwater inflow from groundwater and small drainages flowing off the Inverness Ridge.

Olema Marsh. While the value of Olema Marsh to avian wildlife is well-documented (Evens and Stallcup 1991, 1992, 1993, 1994; Stallcup and Kelly 2004, 2005), information on the other animals that use this system is not as complete. The marsh provides extensive refugia opportunities from both animal and human “predators,” complicating efforts to understand the wildlife community. California red-legged frogs breed in the marsh, but total numbers of this population are not known due to the difficulties of accurately surveying this population (G. Fellers, USGS, pers. comm.). The marsh also supports Northwestern pond turtle, Pacific treefrogs (*Pseudacris regilla*), and bullfrogs, but, again, numbers of the latter, a potential red-legged frog predator, cannot be determined (G. Fellers, USGS, *pers. comm*.). Southwestern river otter used to occur in the marsh, but have not been seen recently, perhaps because impounded conditions in the marsh do not create a sufficient creek gradient to allow passage, at least via water, for otter: otter will move over land, as well as through water, to access areas (J. Evens, ARA, *pers. comm*.). This same issue may account for why no coho salmon, steelhead, tidewater goby, or California freshwater shrimp have been found in Olema Marsh either (Fong 2003; D. Fong, GGNRA, *pers. comm*.; NPS, unpub. data), although this marsh may have served as habitat for all of these historically.

Smolt trapping by the Seashore upstream of Olema Marsh in 1999 captured 21 steelhead – five of which were classified as pre-smolts (Ketcham *in prep.*). Fish species such as stickleback and sculpin were observed in very low numbers in the northern portion of the marsh during 2005, as well as in higher numbers near park headquarters in spring 1999 (NPS, unpub. data). Historically, salmon are believed to have used this watershed, which is one of the reasons that a hunting and fishing club was established during the 1800s. Initially, the fishing and hunting clubs allowed members to fish coho salmon and steelhead trout, but as numbers decreased from overfishing, many clubs began stocking thousands of fish that were not native to this region such as eastern brook trout and Quinnat salmon (Mason 1983). Despite this and other dramatic changes due to agricultural and ranch development, there continued to be reports of 8-14 inch trout in some of the deep pools near the Park's administrative headquarters up until 1982 (B. Ketcham, Seashore, *pers. comm*.). Following 1982, the structure of the creek changed dramatically, with many of the deep pools favored by trout and salmonid species eliminated (B. Ketcham, Seashore, *pers. comm*.). Coho salmon have not been observed, at least in recent times, in the Bear Valley Creek watershed (B. Ketcham, Seashore, *pers. comm*.).

Olema Marsh was at least once considered "one of the most diverse habitats for breeding, wintering, and migrating birds in the Point Reyes area" (Evens 1993). Because of the value of Olema Marsh to birds, breeding bird censuses were conducted between 1984 and 1994 and again in 2004 (Evens and Stallcup 1991; 1992; 1993; 1994; Stallcup and Kelly 2004). During the earlier monitoring, a prolonged drought encouraged conversion of some of the marsh to willow-dominated riparian habitat, and this shift, along with drier conditions in the marsh itself, appear to cause declines from pre-drought numbers of some of the most common breeding birds such as marsh wren, Virginia rail, song sparrow, and salt marsh common yellowthroat, with declines ranging from 36 percent (song sparrow, yellowthroat) to as high as 77 percent (marsh wrens; Evens and Stallcup 1992). Concurrently, numbers of red-winged blackbirds (*Agelaius phoeniceus)* increased by approximately 31 percent, as well as increase in other riparian associates such as black-crowned night heron (*Nycticorax nycticorax*; formerly FSC, S3) and green-backed heron (*Butorides striatus*; Evens and Stallcup 1991, 1992). Between 1984 and the early 1990s, vast flocks of blackbirds often roosted in the marsh at night, and red-winged blackbirds bred actively (Evens and Stallcup 1991). Drought conditions also appeared to attract increased numbers of waterfowl to the marsh, possibly because of lower water levels elsewhere (Evens and Stallcup 1992). In 1993, the drought ended, and populations of many of the previously common bird species rebounded, including marsh wrens, song sparrows, Virginia rails, and saltmarsh common yellowthroat (Evens and Stallcup 1993, 1994). The increase in riparian vegetation continued to attract riparian associates, the three most common being warbling vireo, Swainson's thrush (*Catharus ustulatus*), and Wilson's warbler (Evens and Stallcup 1994).

Between 1991 and 1994, total number of species ranged from 77-81 during the winter and 44-49 species during the spring (Evens and Stallcup 1991, 1992, 1993, 1994). In 2004, this species richness trend reversed, with the number of species totaling 74 in spring and 65 in winter (Stallcup and Kelly 2004). As before, red-winged blackbird, marsh wren, and song sparrow represented generally the most abundant species in autumn, winter, and spring, along with saltmarsh common yellowthroat, which had at least 12 nesting territories during spring 2004 (Stallcup and Kelly 2004; 2005). California black rails were not detected, but relatively high numbers of Virginia rails occurred in all survey periods, and sora frequented the marsh in fall (Stallcup and Kelly 2004, 2005). The expansion of riparian habitat on the west side of the marsh where the Bear Valley Creek flowed prior to 1998 continues to attract an increasing number of riparian associates. As might be expected, the number of waterfowl species using the marsh typically peaks in winter, although many continue to visit throughout the spring. Common waterfowl species included mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*), wood duck (*Aix sponsa*), green-winged teal (*Anas crecca*), cinnamon teal (*Anas cyanoptera*), northern shoveler (*Anas clypeata*), and ring-necked duck (*Aythya collaris*; Stallcup and Kelly 2004, 2005).

Lagunitas Creek. For Lagunitas Creek, as with other California creeks, the story of its fisheries and other resources is strongly interwoven with the history of the watershed and its development since the 1800s. Anecdotal stories told of this area by Spanish explorers and later by European Americans paint a bucolic picture of abundant natural resources, particularly fish and game. Lagunitas, or Papermill Creek as it was once known, reportedly supported a substantial run of steelhead in the late 1800s, estimated at more than 200,000 "young" (<3 inches; Schofield 1899 *in* ARA 2002). Historic coho outmigration to the sea once numbered as many as 3,000 to 5,000 fish annually (Smith 1986).

While watershed development and excessive sedimentation between 1860 and 1950 undoubtedly affected salmonids, as well as other aquatic species, construction of levees and a seasonal gravel dam for impoundment of fresh stream water for pasture irrigation probably ranked as two of the largest impacts to remaining fisheries (ARA 2002). Levee construction precluded fish and other organisms' access to the interior of the former tidal marsh, while the gravel dam largely cut off upstream access and dramatically altered salinity dynamics. These major hydrologic impacts were closely followed in the 1950s with construction of a series of dams for reservoirs in the upper portions of the watershed, substantially reducing sediment loads in the creek (PWA et al. 1993). The temporary gravel dam installed by the Giacominis, known as the old summer dam, impounded waters for almost 1 mile upstream to a point well upstream of the Green Bridge and State Route 1 (KHE 2006a). The long residence time of waters behind the dam resulted in unnaturally warm water temperatures uncharacteristic of natural California coastal systems and essentially eliminated the brackish zone that would naturally move up and down the creek, creating instead a sharp demarcation between salt waters downstream and fresh waters upstream (ARA 2002). This warm, fresh- water impoundment attracted numerous non-native fish species that probably outcompeted and/or foraged upon any native fish species and invertebrates capable of tolerating conditions within the "pool." Seven of the 23 fish species caught in a 1983 survey were non-native species, including largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and black crappie (*Pomoxis nigromaculatus*), that prey on native fish (Bratovich et al. 1984 *in* ARA 2002).

These geomorphic and hydrologic alterations may have initiated a steady decline in population of species such as tidewater goby in Lagunitas Creek (ARA 2002). Within a decade after levees and dams were constructed, tidewater goby, a small annual fish that is adapted to brackish waters and that historically had been recorded within the Lagunitas Creek watershed, was seemingly extirpated from Lagunitas, as well as within all of Tomales Bay. The last sighting in Lagunitas Creek was in 1953 (Swift et al. 1989). One researcher (Wang 1982)*in* ARA 2002) concluded that the absence of tidewater goby in Lagunitas Creek was due to high summer salinities and the inability of the species to migrate upstream due to the gravel dam. Another reason for its decline may relate to the exponential increase in non-native fish with impoundment of warm, fresh waters behind the gravel dam, as non-native fish have been strongly implicated in the species' overall decline (Moyle 1976) *in* ARA 2002). This impoundment probably also negatively affected salmonids, who are sensitive to high water temperatures and predation by non-native species, as well as to obstacles that would limit either the upstream (winter) or downstream (spring, early summer) migration.

In 1997, the Giacominis stopped constructing the gravel dam by the SWRCB, which also mandated minimum instream flow requirements to ensure flow for fisheries. During the summer, freshwater flow rates at Samuel P. Taylor must equal at least 8 cfs, except during documented drought conditions, when they can drop to 6 cfs. During the winter, starting in November, freshwater flow must equal at least 20 cfs. Two years later, a San Francisco State University graduate student conducted some intensive monitoring during the summer and discovered a sharp decline in the number of non-native fish, with the only species present being yellowfin goby and American shad (*Alosa sapidissima*), neither of which is considered a warm water fish (Pearson 2000, ARA 2002). During 105 seining events between June and August 1999, Pearson (2000) recorded approximately 3,300 individuals and 17 species (ARA 2002). Marine fish species such as Pacific herring, topsmelt, surf smelt (*Hypomesus pretiosus*), and shiner perch (*Cymatogaster aggregata*) represented 89 percent of the total catch (Pearson 2000). Other marine species included northern anchovy, bay pipefish, prickly sculpin, and starry flounder (Pearson 2000). Resident estuarine fish species consisted of threespine stickleback, yellowfin and cheekspot (*Ilypnus gilberti*) goby, and staghorn sculpin (Pearson 2000). As with Bratovich et al. (1984), Pearson (2000) also reported capturing Tomales roach (*Lavinia symmetricus* ssp. 2; CSC) -- although in higher numbers than previously caught.

Based on surveys in 2002 and 2005, fish assemblages appear to differ seasonally, which is probably related to a number of factors, including freshwater inflow rates, salinity, and migration of species within Tomales Bay. Estuarine assemblages comprised of threespine stickleback, arrow goby, sculpin, and occasionally bay pipefish appear to dominate most reaches of the creek in the Project Area during low tide or water periods during spring, early summer, and late fall, when freshwater flows are highest. During high tides in these seasons, large schools of topsmelt move in, along with starry flounder (NPS, unpub. data). Starting in mid-summer through early fall, fish assemblages appear to shift to a more marine-dominated one. In August 2002 surveys, a few shiner surfperch were caught in addition to large numbers of topsmelt (ARA 2002). During 1999, the transition was even more dramatic, with surf smelt, bay pipefish, shiner surfperch, prickly sculpin, Pacific staghorn sculpin, and starry flounder only caught during the summer (Pearson 2000).

While coho and steelhead salmon do not spawn in the Project Area, they do migrate through this area when adults move to spawning grounds upstream during the winter and when juveniles move to Tomales Bay and eventually the Pacific Ocean in spring and summer. Adults and juveniles will use transitional zones of estuaries for foraging and refugia from predators, with some steelhead often spending up to a year in estuaries (Smith 1987). Pearson (2000) recorded coho salmon during spring and early summer sampling within the Project Area, while steelhead occurred during the entire monitoring period from April through August 1999. In June 2005, moderate numbers of juvenile steelhead and coho salmon were found upstream of White House Pool in fresh- to brackish sections of the creek, possibly utilizing some of the refugia provided by dense thicket of willows overhanging into creek waters (NPS, unpub. data). During this same period, large numbers of mysid shrimp -- one of the primary prey items for salmon whose numbers have dropped precipitously within the San Francisco Bay estuary -- were found in creek waters downstream of salmon occurrences and in other undiked marshes (NPS, unpub. data). These dense willows also provide potential habitat for California freshwater shrimp, but surveys in 2001 (Fong 2003) failed to find this species within the Project Area.

In March 2002, smolts of another salmon species, chinook (*Oncorhynchus tshawytscha*; FT), were found in the Project Area (ARA 2002). Chinook spawn in Lagunitas Creek and one of its tributaries, San Geronimo Creek, in lower numbers than coho or steelhead salmon (MMWD 2005). The largest runs of chinook salmon typically occur in the Sacramento-San Joaquin River system and large coastal streams from the Russian River north (ARA 2002). However, Marin Municipal Water District has consistently documented Chinook salmon during its 10 years of monitoring, with 2005 being one of the most successful years to date with 105 estimated chinook salmon (MMWD 2005). It is possible that chinook may have always spawned in small numbers in the Lagunitas Creek watershed: chinook fry were planted in Marin County streams in the late 1800s (ARA 2002). In addition to steelhead, coho, and chinook, there have been anecdotal reports of other anadromous species within this section or upstream sections of Lagunitas and Olema Creeks, including chum salmon (*Oncorhynchus keta*), white sturgeon (*Acipenser transmontanus*) and Pacific lamprey (*Lampetra tridentata*; FSC), as well as possibly green sturgeon (*Acipenser medirostris*; FT; ARA 2002, MMWD 2005). White sturgeon is not listed in California and does not spawn in Lagunitas Creek, but occasionally forages in Tomales Bay (ARA 2002). Green sturgeon, which was recently listed, is known to occur in Tomales Bay and "may also forage in Lagunitas Creek" (ARA 2002).

While removal of the summer dam and establishment of mandatory instream flow requirements has probably improved conditions for fisheries and aquatic organisms within Lagunitas Creek, the watershed and its resources are still affected by hydrologic alterations such as upstream dams. As described earlier, these dams greatly alter hydrogeomorphic processes, which can significantly impact resident and non-resident biota. Dams trap sediment that could be used downstream for spawning by salmon and alter geomorphic and sediment transport processes that could impact channel and stream structure and, consequently, habitat availability for salmon. In addition, dams change the structure of freshwater flows, typically decreasing the frequency and duration of instantaneous peak flows and increasing the duration of bankfull or ordinary high water flows, which are more erosive and damaging to habitat and possibly to stream biota, as well. As was mentioned earlier, research on the upper watershed of Lagunitas Creek has pointed to a possible "fining" or increase in the amount of fine sediment in the channel substrate, depletion in sediment recruitment directly downstream of the dams, and increase in the intensity and frequency of peak flows, all of which can affect habitat for aquatic organisms, including salmon (Stillwater Sciences 2004); B. Ketcham, Seashore, *pers. comm*.).

Reservoirs can have a dramatic impact on summer flows, as well. Salinity structure in downstream water bodies can be altered by drastically reducing freshwater inflow, prolonging the period and volume of freshwater inflow relative to natural conditions, or causing unnatural fluctuations -- particularly sharp fluctuations -- in freshwater inflow rates. Many organisms are extremely sensitive to changes in salinity, particularly abrupt changes, as they may not be physiologically tolerant of either increases or decreases in salt content of waters. Highly motile species can move in response to fluctuating salinity, although there may be a transitional period in which aquatic diversity is very low as species re-adjust to changed conditions. However, benthic organisms cannot respond as rapidly. High variation in salinity results in low benthic abundance and diversity (Kimmerer 2004), which is consistent with the general pattern of estuarine diversity, in which relatively few species can withstand the fluctuations between freshwater and brackish water (Remane 1971 *in* Kimmerer 2004). Even under stable salinity regimes, however, benthic species diversity is consistently lowest in low-salinity water (Markmann 1986; Nichols and M.M. Pamatmat 1988; Hymanson et al. 1994; Kimmerer 2004).

Lagunitas Creek's fish and invertebrate resources draw both birds and mammals to the Project Area. The open waters of Lagunitas Creek account for approximately 8 percent of all bird species using the Project Area during the winter and approximately one-third of all species during the autumn (ARA 2002). Most of these species are large waterbirds, including some special status ones such as American white pelican (*Pelecanus erythrorhynchos*; CSC), cormorant, heron, snowy and great egret, osprey, and belted kingfisher (ARA 2002). Only the kingfisher breeds on site (ARA 2002). During autumn, young green-backed herons (*Butorides virescens*) frequent the shoreline of Lagunitas Creek, where willows overhang (ARA 2002). Waterfowl using subtidal portions of Lagunitas Creek included canvasback, greater scaup, lesser scaup, common goldeneye (*Bucephala clangula*), bufflehead, wood duck (*Aix sponsa*), common merganser (*Mergus merganser*), and American coot (*Fulica americana*; ARA 2002). Shorebirds such as greater yellowlegs and spotted sandpiper (*Actitis macularia*) foraged on intertidal mudflats or creek edges at low tides (ARA 2002).

One of the habitat associations that drew some of the highest amount of breeding and autumn bird activity was the Forested and Scrub Shrub Riparian and ruderal Pasture-Grassland association in the Green Bridge

County Park (ARA 2002). Yellow warbler (*Dendroica petechia brewsteri*, CSC) breeds in this and near Inverness Park and is a common fall migrant through riparian corridor (ARA 2002).

As noted before, the southwestern river otter, whose numbers had once dwindled precipitously, low, appeared to have rebounded, at least within the southern portion of Tomales Bay. In addition to the burrow and signs of otter presence near the West Pasture's north levee, otter burrows have also observed near White House Pool (ARA 2002). Reputedly, even Pacific harbor seals (*Phoca vitulina richardsi*) have wandered on occasion up into the estuarine reaches of Lagunitas Creek, although none have been observed since baseline studies were initiated in 2001.

Special Status Fish and Wildlife Species

As of 2005, 63 special status taxa -- two invertebrates; seven fish, one amphibian, one reptile, 50 birds, and two mammal species -- either currently or historically occurred in the Project Area (ARA 2002, Stallcup and Kelly 2004, 2005). Of those 63, at least five federally endangered and two federally threatened have historically or recently been found in the Project Area – four bird species, two fish species, and one amphibian species. A list of special status species with potential to occur in the Project Area can be found in Appendix B.

California red-legged frog

The four federally endangered species observed during baseline studies or documented historically included the tidewater goby, central coast coho salmon, California clapper rail, California brown pelican (*Pelecanus occidentalis californicus*), and Least Bell's vireo (*Vireo bellii pusillus*; FE; SE). The California brown pelican irregularly visits the Project Area in small numbers, typically foraging along Lagunitas Creek shoreline (ARA 2002). As of 2003, the California clapper rail had occurred in four of the last six winters in the undiked tidal marsh north of the West Pasture, however, it has not been sighted since (ARA 2002, J. Evens, ARA, *pers. comm*.). The tidewater goby had not been sighted since 1953, when it was found in Tomasini Creek in 2002 (Fong 2003). Lagunitas Creek supports one of the largest remaining central coast coho salmon populations, and this species migrates through the Project Area during winter, spring, and early summer. One federally endangered species, California freshwater shrimp, was potentially documented as occurring in Lagunitas Creek within the Project Area in summer 1999 (Pearson 2000), but identification was never confirmed, and historic and recent surveys have only found the species on the section of Lagunitas Creek some distance upstream of the Project Area in more freshwater habitats near Shafter Bridge and on lower sections of Olema Creek (Fong 2003).

Federally threatened species in the Project Area include the California red-legged frog and central coast steelhead salmon. Some of the largest remaining populations of the federally threatened California red-legged frog (*Rana aurora draytonii*) occur on the Point Reyes peninsula and adjacent areas. This species was first found in the Giacomini Ranch during the Feasibility Study (PWA et al. 1993). Since 2001, surveys have documented small to moderate breeding populations in the freshwater marsh and Fish Hatchery Creek in the West Pasture (Fellers and Guscio 2002; G. Fellers and P. Kleeman, unpub. data). In addition, the frog occurs in the Olema Marsh (G. Fellers, *pers. comm*.). As with coho, Point Reyes and the Lagunitas Creek watershed represent another important stronghold for steelhead, which has been listed as threatened within the central coast ESU (Evolutionarily Significant Unit). Another federally threatened species, chinook salmon, is also present in the Project Area: this anadromous species spawns in the Lagunitas and San Geronimo Creek watersheds, although in much lower numbers than coho or chinook (MMWD 2005).

Two federally delisted species have been observed, the Aleutian Canada goose (*Branta canadensis leucopareia*) and the American peregrine falcon (*Falco peregrinus anatum*) – the latter is still designated a state-endangered species. The American peregrine falcon regularly forages over the Giacomini Ranch and adjacent undiked marshes, while the Aleutian Canada goose occasionally roosts in the northern portion of the West Pasture (ARA 2002). Green sturgeon, which has been reportedly several times in Lagunitas Creek during recent years, was recently listed as federally threatened, at least for populations spawning in the Sacramento River. Previously, the USFWS had designated federal Species of Concern (FSC), many of which were potential candidates for listing. This designation has been eliminated, but the regional office of USFWS in Sacramento has developed its own list of species of concern, designated in this report as SacFWSSC. The Project Area has supported or currently supports 16 of these species.

State-listed endangered and threatened species totaled at least six, many of which were also federally listed. State-endangered species included American peregrine falcon (FD), California brown pelican (FE), California clapper rail (FE), and Least Bell's vireo. Least Bell's vireo occasionally visit riparian corridor along the southern portion of Lagunitas Creek, but they do not nest here (ARA 2002). State-threatened species consisted of California black rail, bank swallow (*Riparia riparia),* and sandhill crane (*Grus canadensis tabida*). Potential breeding California black rail has been consistently present in undiked marsh north of Giacomini Ranch and, during surveys, in freshwater marsh in West Pasture (ARA 2002). Sandhill crane is a very rare visitor to the flooded pastures in the Giacomini Ranch, and bank swallows also represent rare transients to the Giacomini Ranch, especially in fall (ARA 2002). An additional 20 resident and non-resident taxa are on California's list of Special Concern Species, including the southwestern river otter, osprey, double-crested cormorant, American white pelican, northern harrier, yellow rail, and saltmarsh common yellowthroat (ARA 2002).

CDFG has initiated a process to determine and set conservation priorities for native birds by revising the initial California Bird Species of Special Concern (BSSC) document (Remsen 1978), which subjectively described declining or vulnerable species (PRBO Conservation Science 2006). The revision process, coupled with other recent efforts to develop and implement conservation strategies, led to expansion of the Bird Species of Special Concern concept to include ranking of special concern taxa for conservation priority using objective criteria. Also, the original BSSC list included only full species but the current draft list includes full species, subspecies, and identified populations. The Project Area supports approximately 21 BSSC species. The state has also developed rarity rankings, which is preceded by the letter "S," for wildlife, with rankings ranging from presumed extinct (SX) to secure, common and widespread (S5). Ten of the species have rarity rankings.

Listed below are more detailed descriptions of federally and state listed species that are either resident or commonly occurring in the Project Area.

Tidewater Goby (FE)

The tidewater goby is a small fish that occurs along the coast of California in coastal lagoons and the uppermost brackish areas of larger bays and estuaries (Swift 2003), including several lagoons and estuaries along the Marin-Sonoma coast. Until 2002, this species had not been sighted in the Tomales Bay watershed since 1953, when it was last documented in Lagunitas Creek. In 2002, fisheries surveys found tidewater goby in a leveed section of Tomasini Creek, a downstream tributary to Lagunitas Creek and southern Tomales Bay that runs along the eastern perimeter of the Giacomini Ranch. Since then, it has possibly been also found in a diked slough in the West Pasture in late 2005: the identification is still being confirmed (NPS, unpub. data).

> *Until 2002, the tidewater goby had not been sighted in the Tomales Bay watershed since 1953, when it was last documented in Lagunitas Creek.*

The tidewater goby was listed as endangered in 1994 throughout its entire range. Critical habitat for this species was designated in 2000 and includes 10 coastal stream segments in Orange and San Diego Counties in southern California (65 FR 69693). The most important elements of coastal lagoons and estuary systems for support of goby are a natural hydrological regime, which results in sufficient streamflow, areas of shallow water as well as deep pockets of permanent water, sand and silt substrate, a variety of aquatic and emergent vegetation, and a diversity of prey species; and an environment free from exotic fishes (USFWS).

Tidewater gobies are mostly annual, but some fish may live into a second year (Swift 2003). Because gobies are small and not necessarily good swimmers compared to species such as salmon, their ability to disperse when conditions change or become adverse is poor, with recolonization occurring only if another population exists within about 6.2 miles or less (Swift 2003). Not surprisingly, recent genetic studies show that gene flow is restricted or lacking between groups of populations (Dawson et al. 2001; 2002). Because of this lack of gene flow, considerable genetic variation exists among populations in San Francisco Bay counties, including Marin (Barlow et al. 2001). Recent genetic analyses performed by Jacobs and Earl (Jacobs and Earl 2005) suggest that the Tomasini Creek population may be most closely related to those at three northern coastal marshes -- Estero de San Antonio, Estero Americano, and Salmon Creek – but that the Tomasini Creek population does appear to be genetically distinct and to have differentiated many hundreds, if not thousands, of years ago. Its life history also has implications for the stability of existing populations, with even relatively persistent and large populations such as Rodeo Lagoon having sharp interannual fluctuations in numbers from seven gobies to 100 gobies per square meter within the span of a few years (D. Fong, GGNRA, unpub. data).

As noted earlier, tidewater goby establish either in the brackish reaches of coastal creeks or in permanently or seasonally impounded coastal lagoons with a sufficient freshwater inflow to create brackish conditions. According to the USFWS, goby prefers salinities of 12 ppt, but a wide range of salinities can be tolerated, with reproduction occurring in fresh water (<0.5 ppt) up to at least 25 ppt (Swift 2003). The species may even be able to survive for a few weeks in hypersaline conditions (45 ppt; Swift 2003). Within these systems, fish tend to prefer areas without strong flood scour. Within systems, fish will move up and down the creek with seasonal movement of the brackish water zone.

Some of the largest threats to tidewater goby populations include hydrologic alterations and non-native and native predators (Swift 2003). Artificial structures that constrict or eliminate the interface zone between tidal and freshwater reaches either impact or even eliminate tidewater gobies (Swift 2003). Non-native or introduced aquatic organisms can also negatively affect goby populations. Some of the documented freshwater and brackish water predators on goby include largemouth bass, green sunfish (*Lepomis cyanellus*), striped bass (*Morone saxatilis*), yellowfin goby, and shimofuri goby (*Tridentiger bifasciatus*; Swift 2003). Crayfish may disrupt nesting sites while digging for the eggs in the sand (Swift 2003). The native rainbow trout or steelhead, starry flounder, Pacific staghorn sculpin, and prickly sculpin have also been documented to feed on tidewater gobies in the lower Santa Ynez River and elsewhere (Swift 2003).

Within the Project Area, the species occurs in a section of Tomasini Creek that has been bermed to run against the base of Point Reyes Mesa until it drains into Tomales Bay. The creek supports both open water and vegetated sections. Most of the creek bottom is muddy or a combination of clay and silt (G. Kamman, KHE, *pers. comm*.). The flashboard dam and culvert structure is malfunctioning and allows modified two-way flow, such that the creek is influenced by the full upper range of high tides, but does not drain completely during low tides. This maintains permanent ponding or subtidal conditions within the creek, which may have become intertidal mudflat during low tides if it had been allowed to drain completely. The tidegate, along with natural "bar" features within the creek itself, may have created a "mini-lagoon" that benefits the goby, despite the fact that the substrate and flow conditions are probably not optimal. In addition, as noted earlier, it has also been possibly found in a diked slough in the West Pasture. This slough is not a fluvial or creek system such as Tomasini Creek, but rather appears to drain freshwater surface run-off from a seasonally flowing seep present on the Gradjanski property, as well as surface run-off from overbank flooding of the pasture by Fish Hatchery Creek. It receives tidal influence from Fish Hatchery Creek, which has muted tidal flows with lower amplitude than Tomasini Creek. As with Tomasini, substrate conditions are suboptimal, with the surface substrate being muddy or a combination of clay and silt. Acreage of existing tidewater goby habitat in the Giacomini Ranch totals 6.1 acres.

As with all of the creeks in the Project Area, Tomasini Creek becomes largely fresh to low brackish during the winter and early spring and well-mixed or partially stratified in the summer and fall, with advance of the "salt wedge" upstream starting in spring when freshwater flows begin to drop. By late fall, salinities near the Giacomini Hunt Lodge typically range between 15- to 23 ppt (NPS, unpub. data). While brackish conditions are maintained to some degree by Tomasini Creek, lower water salinities are sustained even during late summer and early fall when surface flows in the creek often dry up (NPS, unpub. data). Groundwater spring and seep flow from the Point Reyes Mesa appear to reduce salinities within the creek even when surface flows in Tomasini Creek cease, although some subsurface flow may persist. The strong influence of groundwater is attested by the large stand of willows that grows on the steep bluff of the Point Reyes Mesa directly to the west of the creek, as well as by hydrodynamic modeling results (KHE 2006a). Because of the seasonal nature of freshwater influence, salinities in the diked slough in the West Pasture, the West Pasture Old Slough, are typically higher than in Fish Hatchery Creek, although scouring flood flows during the winter are minimal to non-existent. Circulation patterns in this slough vary from well-mixed and brackish to saline (22.4 to 30 ppt) in the late summer and early fall to strongly stratified at times and fresh to brackish (0.2 to 24.7 ppt) in the winter through early summer. The hydrology of these areas is discussed in more detail under Water Resources.

In 2002, 12 tidewater gobies were caught in March (ARA 2002). Numbers remained fairly low in subsequent sampling conducted between 2002 and 2005, with 20 gobies caught in 2003, 22 in 2004, and six in 2005 (NPS, unpub. data). Five gobies identified as tidewater goby were found in the West Pasture Old Slough in November 2005 (NPS, unpub. data). In addition to goby, fish sampling revealed low to moderate numbers of some of the native predators of goby, including prickly sculpin, staghorn sculpin, and *Oncorhynchus mykiss* (steelhead or rainbow trout). Numerous crayfish have been observed in East Pasture drainage ditches, which are separated from Tomasini Creek by the levee, and starry flounder occur in Lagunitas Creek directly downstream of the creek's mouth. Another potential predator could be bullfrog, which has been observed or heard in the creek in areas where the fish has frequently been caught.

In 2006, tidewater goby were also found in non-tidal portions of the East Pasture. During the December 2005 storm, these fish may have been washed into the East Pasture Old Slough from Tomasini Creek when the Tomasini Creek levee breached, or they may have entered the slough from the bay. During the storm, the entire northern portion of the East Pasture was flooded and connected through elevated surface waters with Lagunitas Creek and Tomales Bay. Tidewater goby have been found outside the mouth of Tomasini Creek. Lastly, these fish may have entered the East Pasture Old Slough Pond through the one-way tidegates if the tidegates were malfunctioning and allowing water in as well as out. During surveys, dead marine fish species were discovered in the pond, suggesting that gobies probably entered from the Lagunitas Creek side of the pond. The pond is bermed off from the rest of the East Pasture Old Slough, because the Giacominis once reputedly used this area for hunting. This pond consistently has brackish water salinities, probably because the tidegates leak. As with Tomasini Creek and the West Pasture Old Slough, substrate conditions are suboptimal, with the surface substrate being muddy or a combination of clay and silt.

California red-legged frog (FT)

The California red-legged frog is the largest native frog in the western United States (USFWS). It is one of two subspecies of the red-legged frog found on the Pacific coast; the other is the northern red-legged frog (*Rana aurora aurora*; USFWS). The California red-legged frog once ranged across much of California, including portions of the Sierra Nevada Mountain Range, where it is believed to be the title character of Mark Twain's famed short story, "The Celebrated Jumping Frog of Calaveras County" (USFWS). In 1865, when the story was written, red-legged frogs were the largest frogs in the state; bullfrogs were not introduced to California until 1896 (USFWS). The name of this species derives from its belly and hind legs, which are often red or salmon pink in adults (USFWS).

The California red-legged frog was federally listed as a threatened species in 1996. , 1996. It has been completely extirpated from the floor of the Central Valley (Fisher and Shaffer 1996) and is nearly gone in both the Sierra Nevada foothills and in the southern quarter of its range (Fellers and Guscio 2002). In a few parts of the central Coast Range, there are still large, vigorous populations, some of which probably rival what was present 200 years ago (Fellers and Guscio 2002). Several robust populations still exist in the San Francisco Bay area (especially Alameda and Contra Costa Counties) and in the coastal drainages from San Mateo County (just south of San Francisco) south to Santa Barbara County (Fellers and Guscio 2002).

Some of the largest remaining populations in California are at Point Reyes National Seashore (Marin County) where there are more than 120 breeding sites with a total adult population of several thousand frogs (Fellers and Guscio 2002). Most of the breeding sites are artificial stock ponds constructed on lands that have been grazed by cattle for 150 years (Fellers and Guscio 2002). Interannual variability in numbers for some of the most stable populations such as Cemetery Pond in Olema Valley totals less than 25 percent (G. Fellers and P. Kleeman, USGS, *pers. comm*.). Within some of these ponds or impounded estuaries, both adult and juvenile frogs have been found in areas that are moderately saline (B. Ketcham, Seashore, *pers. comm*.). Critical Habitat for this species was recently reproposed in November 2005 and includes two proposed Critical Habitat Units in Marin County, one which encompasses the entire Drakes Estero watershed and one which appears to incorporate the Chileno and Walker Creek valleys some distance northeast of the Project Area (USFWS 2005). The Project Area is currently included in neither proposed Critical Habitat Unit (USFWS 2005).

This species is threatened within its remaining range by a wide variety of human activities including urban encroachment, construction of reservoirs and water diversion, contaminants, agriculture, and livestock grazing (USFWS 2000). While bullfrogs have frequently been called a threat, or even a primary cause of the declines, there is almost no direct evidence that this is the case (Fellers and Guscio 2002), and it is at least as likely that non-native fish (e.g., striped bass, green sunfish, catfish, mosquitofish) play a significant role in the decline of native ranid frogs (Hayes and Jennings 1986).

Red-legged frogs require aquatic habitat for breeding, but also use a variety of other habitat types, including riparian and grasslands and other upland areas (USFWS; G. Fellers, USGS, *pers. comm*.). Adults often utilize dense, shrubby or emergent vegetation closely associated with deep-water pools that pond for at least six months (~ December through June) with fringes of cattails and dense stands of overhanging vegetation such as willows as breeding and rearing habitat (USFWS). During the summer months, frogs will often move out of breeding habitat into adjacent riparian areas (Fellers and Guscio 2002). Salinity can influence suitability of habitat for red-legged frogs (Fellers and Guscio 2002). Published tolerance criteria indicate that larvae and adults can tolerate salinity levels as high as 7.0 ppt, while eggs require salinities of less than 4.5 ppt (Jennings and Hayes 1989). However, anecdotal information from the Seashore and other areas along the coast suggest that frog populations, including egg masses and tadpoles, can persist in areas with higher average salinities, possibly because frogs are using pockets or lens of freshwater in otherwise saline environments.

Historical records of red-legged frogs suggest that red-legged frogs have been present in the vicinity of the Giacomini Ranch since 1922 (Fellers and Guscio 2002). The species was first observed on the Giacomini Ranch during baseline wildlife surveys conducted during 1993 (PWA et al. 1993). A few individuals were observed in a drainage ditch in the East Pasture (PWA et al. 1993). Surveys conducted in the fall, winter, and spring of 2001-2002 showed that, while a few frogs were found in most areas, the main concentration was in the freshwater marsh in the West Pasture adjacent to Fish Hatchery Creek and, to a lesser extent, in Fish Hatchery Creek itself (Fellers and Guscio 2002). Acreage of the West Pasture freshwater marsh totaled 7.2 acres, all of which is potential red-legged frog breeding habitat. Another approximately 1.0 acre of breeding habitat occurs in portions of Fish Hatchery Creek. In 2001-2002, 21 adult frogs were detected in the freshwater marsh, and 18 adult frogs, in Fish Hatchery Creek (Fellers and Guscio 2002; Table 18). Based on the number of egg masses observed, Fellers and Guscio (2002) estimated the total number of adult frogs during that season in the West Pasture at 90-100 individuals In the East Pasture, adult red-legged frogs were sparsely distributed and unlikely to breed (Fellers and Guscio 2002). A total of six sightings occurred in the East Pasture, and no eggs or tadpoles were observed (Fellers and Guscio 2002). During the summer, frogs moved out of the freshwater marsh, possibly into the riparian corridor along Sir Francis Drake Boulevard or across the street (Fellers and Guscio 2002), although it is possible that the frogs are also using the extensive pastures within the Giacomini Ranch (G. Fellers, USGS, pers. comm.).

The following winter, culverts on Fish Hatchery Creek at the north levee collapsed, allowing more tidal inflow into the West Pasture and the freshwater marsh. The culverts were repaired in fall 2003, reducing tidal inflow, but only a few adults and no egg masses or tadpoles were observed in the West Pasture freshwater marsh and Fish Hatchery Creek during the 2003-2004 season (G. Fellers, USGS, *pers. comm*.). Since then, frog numbers have increased slightly, but not to 2001-2002 levels (Table 18). In 2004-2005, approximately 10 adult red legged frogs were detected, but no egg masses were observed (G. Fellers and P. Kleeman, USGS, unpub. data). In January 2006, a survey following the second largest recorded storm in history found 12 adult frogs and 15 egg masses (G. Fellers and P. Kleeman, USGS, *pers. comm*.).

As was discussed under Water Resources, salinity intrusion into the West Pasture currently appears to be controlled by extreme high tide events and long residence time during winter months, not by evapotranspiration during the summer months, as might be expected. Extreme high tides in Tomales Bay exceeding approximately 6.2 ft NAVD88 cause water levels within the muted tidal West Pasture to increase to 5.25 ft NAVD88, the uppermost part of the tidal range in the pasture, which then allows tidal waters to overbank flood and flow into the central and lowest elevations portions of the freshwater marsh. The southern half of the marsh does not appear to be affected by salinity intrusion, perhaps because of high perennial freshwater inflow from the 1906 Drainage and because elevations are higher. Interestingly, despite the availability of suitable habitat in the southern portion of the marsh, most of the frogs detected are in the central portion of the marsh (P. Kleeman, USGS, *pers. comm*.), which suggests either that breeding attempts ultimately may not be successful or that the frogs are somehow find pockets or lens of freshwater that enable egg masses and tadpoles to persist successfully. Bullfrogs and bullfrog tadpoles were observed in certain portions of the East Pasture, but not in the West Pasture until 2006, when at least one bullfrog was heard calling in the West Pasture freshwater marsh (P. Kleeman, USGS, *pers. comm*.). In the West Pasture, black-crowned night herons might be one of the potential red-legged frog predators (Fellers and Guscio 2002).

Red-legged frog adults and tadpoles also occur in what is believed to be low to moderate numbers at Olema Marsh, particularly along its western perimeter where there are sizeable small drainage and seep influences (G. Fellers, USGS, *pers. comm*.). However, the exact size of this population is unknown (G. Fellers, USGS, *pers. comm*.). There are significant numbers of bullfrogs (G. Fellers, USGS, *pers. comm*.). Acreage of breeding red-legged frog habitat totaled 39.8 acres, which represents the entire marshy portion of Olema Marsh. The adjacent riparian area provides potential over-summering habitat for red-legged frog, but the grasslands to the east along the shutter ridge may be too dry.

TABLE 18. CALIFORNIA RED-LEGGED FROG BREEDING IN WEST PASTURE FRESHWATER MARSH AND ADJACENT FISH HATCHERY CREEK

Year	Adults	Egg masses	Minimum adults present
2001-2002	18	45	90
2002-2003	No night or egg mass surveys during breeding season		
2003-2004	4	-	4
2004-2005	10	-	10
2005-2006	12	15	30

Central California coast coho salmon (FE), central California steelhead (FT), and coastal California chinook salmon (FT)

Central California coast Coho, Central California coastal steelhead, and southern Oregon/California coastal chinook salmon occur in several creeks on the Point Reyes peninsula and in the Lagunitas Creek watershed that drains portions of the Seashore and GGNRA, as well as MMWD, state park, and private lands. Chinook salmon have been documented primarily in the Lagunitas Creek-San Geronimo Creek watersheds (MMWD 2005).

Central California coast coho salmon was first listed as a threatened species in 1996, although it was reclassified in August 2005 as endangered. Its ESU includes all naturally spawned populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay. Critical habitat for this species was designated in 1999 and includes all river reaches accessible to listed coho salmon from Punta Gorda in northern California south to the San Lorenzo River in central California. Designated critical habitat for coho in the Seashore includes all accessible estuarine and stream areas in the coastal watersheds of Marin County except areas above longstanding, naturally impassable barriers or above Peters Dam on the mainstem of Lagunitas Creek and Seeger Dam on Nicasio Creek (NOAA-Fisheries 1996).

Steelhead was listed as a threatened species in 1997. The steelhead ESU includes all naturally spawned populations of steelhead (and their progeny) in California streams from the Russian River to Aptos Creek, and drainages of San Francisco and San Pablo. Critical Habitat for the federally threatened central coast steelhead salmon population went into effect in January 2006 and is designated to include all river reaches and estuarine areas accessible to listed steelhead in coastal river basins from the Russian River to Aptos Creek, California (inclusive), and the drainages of San Francisco and San Pablo Bays. In Tomales and Drakes Bays, Critical Habitat does not include areas upstream of Peters Dam, Seeger Dam, and Soulajule Dam.

California coastal chinook salmon was initially listed in 1999 as federally threatened and was redesignated in August 2005. Critical habitat for this species also became effective in January 2006 and includes many watersheds on the northern California coastline extending down to the Russian River watershed, but not as far south as Tomales Bay. Chinook salmon that spawn in the Tomales Bay watershed are believed to be strays from the Russian River population (B. Ketcham, Seashore, pers. comm.), although chinook fry have historically been planted in the Lagunitas Creek watershed, as well (ARA 2002).

Coho, steelhead, and chinook salmon are anadromous fish species. Anadromous species spend a portion of their life cycle in marine waters and a portion, specifically spawning and rearing, in fresh waters. There are differences between steelhead, coho, and chinook salmon life cycles. While virtually all coho in western Marin County watersheds have an 18-month freshwater life cycle, steelhead juveniles may migrate to the ocean after 18 months or extend freshwater residence for up to three years. Most coho return to spawn after 18 months, but steelhead may spend several years in the ocean before returning to spawn. Additionally, steelhead may make several spawning migrations while all coho spawn once and die. Most juvenile chinook along the California coast migrate out to sea within the first year of their life (i.e. "ocean-type" chinook) and spend three years in the open ocean (Nielsen Monterey Marine Sanctuary website). Some chinook, however, spend more than one year in freshwater bays or estuaries before moving into the ocean environment (Healey 1991) *in* (Nielsen) website).

Coho salmon and steelhead use the upper portions of coastal creek watersheds for spawning and rearing. Coho salmon tend to prefer relatively low-gradient systems with larger watersheds. Chinook salmon will spawn in either mainstem portions of rivers and creeks or tributaries.
All species spawn in gravelly portions of streams where particle-size distribution enables eggs that are laid to remain adequately oxygenated. From anywhere from one to three years later, the juveniles migrate downstream into the lower estuarine areas where they remain for a period of time, foraging and adjusting to the saltwater before migrating into the open ocean. Spawning adults also spend some time in downstream or estuarine reaches of creeks, while they wait for the appropriate flow conditions in associated tributaries.

Lagunitas Creek watershed, including Olema Creek, was believed to support 10 percent of the remaining coho population.

Most historic information on salmonid numbers in the Tomales Bay watershed is anecdotal. These historic accounts suggest that salmonids were abundant in the Tomales Bay watershed before extensive alteration by dam construction, logging, and stream channelization and that runs were sizeable enough to support a fishery in the bay at the end of the 1800's. Local residents recounted stories of "salmon runs" and "excellent trout fishing" along Lagunitas and Olema Creeks, which actually may refer to young steelhead, often indistinguishable from rainbow trout during the three-year period they typically spend in fresh water. Interviews with long time residents and fisheries managers suggest that coho and steelhead in the Point Reyes area have been declining since the turn of the 20th century, with significant declines occurring as late as the mid-1950's. At the time listing was being considered for coho, steelhead, and chinook salmon, the Lagunitas Creek watershed, including Olema Creek, was believed to support 10 percent of the remaining coho population (Brown et al. 1994; NOAA-Fisheries 1996).

For most drainages, only data on coho salmon abundance have been gathered. Watershed monitoring efforts have documented a general trend in increased juvenile coho salmon in Lagunitas Creek and other Tomales Bay and coastal Marin drainages, although there have been years with fewer fish such as 1998-2000 and 2002-2003 (Seashore*, in prep.*; MMWD 2006). In Lagunitas Creek, juvenile coho numbers have ranged between approximately 4,500 in 2004 and 8,500 in 2005 since 2001, with numbers generally increasing (MMWD 2006). Juvenile surveys for 11 years have resulted in estimates of 4,818 ± 2,850(SD) per year and 27,091 ± 7,169 (SD) for steelhead (MMWD 2006). In Olema Creek, one of the largest tributaries to Lagunitas Creek, juvenile coho numbers have ranged between approximately 3 fish per square meter in 1998-1999 and approximately 50 fish per square meter in 2001-2002 (Seashore, *in prep*.). Spawner surveys for 10 years have resulted in estimates of 251 ± 117 (SD) coho redds per year in the Lagunitas Creek watershed (MMWD 2005). Coho spawning on the mainstem takes place largely in Samuel P. Taylor State Park, upstream of Seashore- and GGNRA-administered lands (Trihey & Associates 1994; 1996; 1997). Coho numbers appear to be strongly affected by changed ocean productivity patterns associated with the Pacific Decadal Oscillation, which shifted from the Alaska Current to the California Current in the late 1990s (Seashore, *in prep*.).

The presence of anadromous species such as steelhead and coho salmon in the southern portion of Tomales Bay is typically restricted to adults that are migrating into the upper watersheds for spawning and outmigrating smolts. Most of these species are moving through Lagunitas Creek on their way up or out of the upper portions of the Lagunitas and Olema watersheds. The Project Area, then, provides primarily transitional habitat for salmonids currently that are either migrating upstream to spawn or outmigrating to the estuary and, eventually, the ocean. Many salmonids in other systems use estuaries for rearing for an extended period before migrating to sea (Reimers 1973; Simenstad et al. 1982)and estuarine marsh channels are used by some salmonids as nursery habitats (Levy and Northcote 1982; Simenstad et al. 1982). Research conducted by fisheries scientists in the Skagit delta and elsewhere shows that estuarine habitat is extremely important in the life cycle of wild chinook salmon (Aitkin 1998), although its importance for coho salmon appears to be more geographically and temporally variable(Magnusson and Hilborn 2003; Miller and Sadro 2003). In some northern and central California systems that close annually due to decreased freshwater flow and migrating sandbars, fall runs of chinook salmon are literally forced to rear in estuaries during the summer until fall rains reopen the mouth (Busby and Barnhart 1995).

Whether for a few days or a few months, most anadromous fish use the heavily vegetated side channels and blind (dead-end) sloughs of a healthy estuary to escape predators and acclimate to salt water (Simenstad et al. 1982). When estuaries are leveed, juveniles are forced into main channels where water is deep, currents are strong, food is scarce, and predators can easily find them. Use of marshes in Tomales Bay has not been as well studied, and construction of levees and tidegates within the Project Area preclude use of the Giacomini Ranch East Pasture and may restrict the amount of use in muted tidal areas. A list of the infrastructure and management practices that negatively affect both the opportunity for salmonid passage and rearing/refugia and capacity to support salmonids, even if opportunity exists, can be found in Table 7 under Water Resources. Dams, culverts, tidegates, and flashboard dam structures eliminate or restrict the opportunity for salmonids to move upstream to spawning areas, while levees, floodplain development, channel excavation, and channelization activities restrict opportunity for development of off-channel refugia such as secondary channels that can be used by fish during spawning or outmigration in both upstream and downstream reaches. Even if opportunity exists, the capacity of these systems to support salmonids can be negatively affected by trapping of sediment by dams, water diversions, pollutant discharges to creeks, increases in turbidity associated with channel excavation, and other factors that affect the potential for salmon to thrive. One measure that has been developed to assess the potential for an estuarine system to provide refugia and foraging opportunities for salmon is total aquatic edge or the linear perimeter of creek provided by a wetland. Currently, approximately 14.9 miles of aquatic edge would appear to be available to salmonids for foraging, refugia, and other uses in the Project Area.

The presence of the red-legged frog restricted the ability to conduct electrofishing surveys for federally endangered and threatened salmonids during baseline wildlife surveys, but O*ncorhynchus mykiss* juveniles – presumed to be steelhead -- have been observed on Fish Hatchery Creek and Tomasini Creek on several occasions (ARA 2002, NPS, unpub. data). Both Fish Hatchery and Tomasini Creeks reputedly had historic runs of steelhead. Populations of coho salmon are unlikely to have occurred in at least Fish Hatchery Creek, because of the small size of the watershed and the high stream gradient (B. Ketcham, Seashore, *pers comm*.). The lower portion of the watershed that falls within the Giacomini Ranch does not provide appropriate spawning habitat conditions (i.e., no riffle/pool complexes with appropriately sized gravel in riffles, etc.).

A few coho juveniles were found in Tomasini Creek in summer 2005 (NPS, unpub. data), although long-term sustainability of any spawning population is uncertain due to the sharp drawdown of water in the creek that occurs most summers. Information on anadromous species runs in Bear Valley Creek is also poor, but smolt trapping by the Seashore upstream of Olema Marsh in 1999 netted 21 steelhead – five of which were classified as pre-smolts (Ketcham, *in prep.*). Coho salmon have not been observed, at least in recent times, in the Bear Valley Creek watershed (B. Ketcham, Seashore, *pers. comm*.).

In addition to these smaller tributaries, steelhead and coho juveniles also occurred in the mainstem of Lagunitas Creek during summer surveys in 1999 and 2005 (Pearson 2000); NPS, unpub. data): these are probably juveniles and smolts that are outmigrating to Tomales Bay and the Pacific Ocean. Chinook salmon have not been documented in the Project Area, although they must migrate through the Project Area on their way to spawn in the upper reaches of Lagunitas Creek and San Geronimo Creek.

California black rail (ST)

The California black rail is listed as threatened under the California ESA. Black rails primarily use tidal salt marsh habitat, but they are also observed in freshwater marsh (Grinnell and Miller 1944; Manolis 1978; Evens and Page 1986; Evens et al. 1991; Aigner et al. 1995).

The species' range is currently confined to the northern San Francisco Bay Estuary, with small, isolated populations along the outer coast in Tomales Bay, Bolinas Lagoon, Morro Bay, and Bodega Bay (Manolis 1978, Evens et al. 1991); in the Sacramento Valley and foothills (Aigner et al. 1995); and in the Colorado River basin (Evens et al. 1991). However, these locations outside the San Francisco Bay are believed to support less than 10 percent of the total population, and, because of fragmentation and small sizes of these populations, they are susceptible to stochastic extinctions (Evens et al. 1991).

Former breeding populations in Central and South San Francisco Bay and the coastal marshes of southern California are apparently extirpated (ARA 2002). The historic and ongoing pressures of agriculture, salt production, and urbanization has reduced tidal marshlands of San Francisco Bay by an estimated 85 percent (Goals Project 1999), and there has been a concomitant reduction in Black Rail populations supported by that habitat (Evens et al. 1991). Early in the 20^{th} century, black rails were apparently very common in the tidal marshes of Tomales Bay near Point Reyes Station (Grinnell and Miller 1944). This population suffered habitat loss and undoubtedly a great reduction in numbers following diking and draining of these marshlands in the mid-1940s with the development of the Giacomini Ranch (ARA 2002).

As of 1994, the undiked marsh north of the Giacomini Ranch appeared to support a breeding population of at least seven pairs of California black rails (Evens and Page 1986; Evens and Nur 2002). Breeding individuals have also been detected in intermittent years at Olema and Bear Valley Marshes, immediately south of the Giacomini Ranch (ARA 2002). During baseline surveys, black rails were detected in the Giacomini Ranch and in Olema Marsh (ARA 2002). Territorial black rails were calling on territories in May-June 2002 and were assumed breeding in the West Pasture freshwater marsh (ARA 2002). Small numbers (1-2 individuals) also occurred within the Project Area in brackish and freshwater marsh (ARA 2002). There is no recent information since 2001-2002 on the number of breeding pairs, although it is possible that numbers have decreased (J. Evens, ARA, *pers. comm.).* Isolated satellite populations such as Tomales Bay would be expected to have high variability – perhaps as much as 50 percent variance – in annual numbers of rails (J. Evens, ARA, pers. comm.). Some of these populations may function as meta-populations such that a local sub-population may go extinct some years, only to be re-colonized in subsequent years by strays from San Francisco Bay (J. Evens, ARA, *pers. comm*.). The high rate of predation that occurs in the Tomales Bay population likely exacerbates the meta-population effect.

Within the San Francisco Bay region, black rails tend to occur in larger undiked marshes associated with larger rivers and in some bayshore parcels, particularly those associated with the mouths of rivers of creeks (Evens et al. 1989). A single pair of rails can occupy and breed in marshes as small as 1.2 acres, however their ability to persist and to sustain a population would be reduced in such a small area and would be dependent on contiguity to other habitat (J. Evens, ARA, *pers. comm*.). A significant positive relationship exists between marsh size and both presence and density of rails (J. Evens, ARA, *pers. comm*.). In a large, productive marsh, black rail territories may be small, i.e. < 1.2 acres. There is no information on breeding territory size for black rails in Tomales Bay, but a recent San Francisco Bay-wide study assessed average territory size for a number of marshes (Herzog et al. 2004) . Mean number of breeding birds in San Francisco Bay marshes averages 0.11 individuals per acre, although variation in the mean number of breeding birds per hectare in marshes was fairly high, ranging from 0.02 to 0.26 individuals per acre (Herzog et al. 2004).

Unlike clapper rails, black rails both forage and nest in the mid- to high marsh plain, well above the low marsh and intertidal mudflats favored by clapper rails. Relationships between black rail presence and habitat variables in San Francisco Bay include vegetation height, presence of alkali heath (an indicator of high elevation marsh habitat), and absence of amphipods (indicators of lower elevation marsh). The condition of transitional vegetation along the upland edge adjacent to marshes is also a factor in habitat suitability for rails (Evens and Page 1986). Other variables that help explain the patchy distribution of black rails in tidal marshes of the San Francisco Bay region are patch size, patch distribution (contiguity), patch configuration (linear vs. broad), predator populations, hydrological cycles, and fluctuations in water level (Evens et al. 1989; Evens et al. 1991; Flores and Eddleman 1993). During higher high tides, black rails move to higher elevations in marshes or adjacent upland areas to escape floodwaters, because rails are poor fliers and unable to fly long distances. To minimize predation pressure, high tide refugia habitat needs to be above the higher high tide water levels and well-vegetated with at least medium-sized plants to provide cover from predators that use high tides as an opportunity to prey on rails (J. Evens, ARA, *pers. comm*.). Black rail habitat in the Project Area and adjacent undiked marsh to the north of the Giacomini Ranch currently totals 120 acres, with approximately 39 acres of refugia habitat, some of which is the Giacomini Ranch levees. Within the immediate Project Area, black rail habitat totals approximately 59.3 acres with 32.4 acres of high tide refugia. While the levees are well above most of the higher high tides, they are often poorly vegetated due to trampling from cattle and people and are subject to disturbance pressures from people seeking to view the rails who may inadvertently flush them into the open where they are vulnerable to predation.

California clapper rail (FE, SE)

The California clapper rail is one of the largest rails (family Rallidae), measuring 13-19 inches from bill to tail (USFWS). The California clapper rail was designated as Endangered throughout its entire range in 1970 (35 FR 16047). A joint Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan was published in 1984, and both species will be included in the Tidal Marsh Ecosystem Recovery Plan, currently under review (USFWS). No Critical Habitat has been designated for this species. The California clapper rail is also designated as Endangered by the state, along with two other subspecies (*levipes* and *yumanensis*) that do not occur locally (CDFG 2005).

Although once more widely distributed along the California coast, present distribution is restricted almost exclusively to the emergent salt and brackish tidal marshes of San Francisco Bay and the Suisun Delta (ARA 2002). Recent records from coastal estuaries outside of San Francisco Bay are sporadic and represent presumed dispersants or vagrants (ARA 2002). The constriction of the clapper rail's range appears to have resulted from numerous factors, including diking or development of habitat, freshwater habitat conversion, habitat fragmentation, lack of high-tide refugia, mercury accumulation in eggs, and increase in predators such as the non-native red fox and Norway rat (*Rattus norvegicus;* USFWS).

Throughout their distribution, California clapper rails occur within a range of salt and brackish marshes. Clapper rails have rarely been recorded in non-tidal marsh areas (USFWS). In south and central San Francisco Bay and along the perimeter of San Pablo Bay, rails typically inhabit salt marshes dominated by pickleweed and Pacific cordgrass (USFWS). In the north Bay (Petaluma Marsh, Napa-Sonoma marshes, Suisun Marsh), clapper rails also live in tidal brackish marshes which vary significantly in vegetation structure and composition (USFWS). Use of brackish marshes by clapper rails is largely restricted to major sloughs and rivers of San Pablo Bay and Suisun Marsh, and along Coyote Creek in south San Francisco Bay (USFWS). As with black rails, marsh size is positively correlated with the presence and density of clapper rails: research has shown that approximately 250-acre marshes are needed to support optimal densities, but smaller marshes (~2.5 – 5 acre minimum) will support clapper rails, especially when adjacent to larger marshes (J. Evens, ARA, *pers. comm.*). Clapper rails tend to prefer marshes with an intricate, dendritic slough network composed of very small or fourth order creek channels (ARA 2002). Low marsh areas with sparse vegetation, mudflats, and tidal sloughs are important foraging areas for rails (ARA 2002). Higher marsh areas with dense vegetation are used for nesting and high-tide refugia (Albertson and Evens 2000).

In the early 1900s, when tidal marshes were more extensive, clapper rails were reported as occurring in Tomales Bay (Grinnell and Miller 1944). In 1980, one bird was heard in the portion of the East Pasture adjacent to Tomasini Creek (J. Evens, unpub. field notes). Since then, the species has been largely absent, although individuals were sighted for years in the undiked marsh north of the Giacomini Ranch during fall and winter between 1995 and 2001 (J. Evens, R. Stallcup, unpub. field notes). There are no recent breeding records, however. Except for the “intermittent presence of wandering or wintering birds,” the population of clapper rails in Tomales Bay appears to be extirpated (ARA 2002), despite the fact that the northern portion of the Project Area and the adjacent undiked marsh offer at least 116.8 acres of foraging and nesting habitat, in addition to the 39 acres of high tide refugia.

California freshwater shrimp (FE)

The California freshwater shrimp was listed by the USFWS as endangered (55 FR 43884) in 1988. This species is the only extant member of the genus (Fong 2003).

The shrimp is found in low elevation (<116 m), low-gradient (generally <1 percent slope) perennial freshwater streams where banks are structurally diverse with undercut banks, exposed roots, overhanging woody debris, or overhanging vegetation (Fong 2003). As its name would suggest, California freshwater shrimp is believed to occur only in freshwater conditions (<0.5 ppt) within streams in the watershed, although it may be able to temporarily tolerate increases in salinity of up 16 to 17 ppt (USFWS 1998).

The shrimp is endemic to 17 coastal streams in Marin, Sonoma, and Napa counties north of San Francisco Bay, California (Fong 2003). Within the Seashore and GGNRA, the shrimp is found exclusively within the Lagunitas Creek watershed. It has also been found in Walker Creek in Tomales Bay (Serpa 1992). The shrimp was first observed and collected in Lagunitas Creek in 1877 (Hedgpeth 1975). The current, known range of the shrimp within Lagunitas Creek extends from Shafter Bridge in Samuel P. Taylor Park to roughly 1 mile below the confluence with Nicasio Creek (Hedgpeth 1975; Serpa 1991). Near the Project Area, the shrimp has been found in lower Olema Creek (Fong 1999).

As part of baseline surveys for the proposed project, habitats were surveyed using a qualitative ranking system developed by Serpa (1996) to evaluate habitat suitability of streams for shrimp. This system evaluates features known to be important to shrimp such as water depth, presence or absence of undercut banks, etc (Fong 2003). All surveyed habitats within the project area were generally rated as either "fair" or "poor" sites for shrimp, and no California freshwater shrimp were captured during surveys in September 2001 (Fong 2003). Many of the required habitat components were either absent or not available on a consistent basis (Fong 2003). The presence of the introduced mosquitofish in the ditches and creeks in the Giacomini Ranch pastures likely precludes the presence of freshwater shrimp.

In Lagunitas Creek itself, operation of the gravel summer dam for more than 50 years would seemingly have increased the amount of habitat for shrimp, as dam impounded freshwater for more than 1 mile upstream of the Green Bridge. However, the warm temperatures within the "pool" attracted a significant number of non-native fish (Bratovich and Kelley 1988) that may have preyed upon freshwater shrimp, thereby decreasing the quality of the habitat (Pearson 2000).

Two years after the dam was permanently removed, Pearson (2000) reported finding three individuals of California freshwater shrimp during surveys between April and August 1999 in "freshwater" conditions, with two individuals found near the location of the old summer dam underneath overhanging riparian trees. However, it is unclear from the report whether identification of these individuals was positively confirmed, and not much information was included in the report as to exactly when the individuals were caught. Fong (2003) and subsequent surveys (NPS, unpub. data) have repeatedly found non-native brackish water or Korean shrimp (*Palaeomon macrodactylus*) in Lagunitas Creek upstream of White House Pool near the old summer dam location.

Threats to existing populations of freshwater shrimp include "introduced fish, deterioration and loss of habitat resulting from water diversion, impoundments, livestock and dairy activities, agricultural activities and developments, flood control activities, gravel mining, timber harvesting, migration barriers, and water pollution" (USFWS 1998). All of these threats have historically occurred along Lagunitas and Olema Creeks.

California brown pelican (FE)

California brown pelican was listed as federally Endangered in 1970. It commonly occurs on local estuaries and nearshore waters as a non-breeding visitor, particularly during summer and fall, with several hundred individuals sometimes present in Tomales Bay (ARA 2002). Winter numbers in Tomales Bay are lower, ranging as high as 56 (Kelly and Tappen 1998). It irregularly visits the Project Area in low numbers, most commonly in the fall when it forages on the shoreline of Lagunitas Creek near its mouth (ARA 2002).

Least bell's vireo (FE, SE)

The Least Bell's vireo was once widespread throughout California, but its numbers have declined precipitously. It inhabits riparian woodlands with tall trees and shorter thick shrubs. In 1980, the state of California listed this species as endangered, and in 1986, the USFWS followed suit. At one point, the vireo was known to breed from interior northern California near Red Bluff in Tehama County south through the Sacramento and San Joaquin valleys and Sierra Nevada foothills and in the coastal ranges from Santa Clara County south to the approximate vicinity of San Fernando in Baja California. Currently, its breeding range is in Southern California, with large populations in Riverside and San Diego counties and smaller populations in Santa Barbara, Ventura, and San Diego counties and in northern Baja California. In early 1994, USFWS designated about 38,000 acres at 10 localities in portions of six counties in Southern California as "critical habitat." The vireo is threatened by loss and degradation of its habitat through human and human-induced activities and by nest parasitism of the brown-headed cowbird (*Molothus ater*). Adverse impacts to vireo habitat result from clearing and other impacts to riparian habitat. This species occurs as an extremely rare vagrant in riparian corridor along southern end of Lagunitas Creek (ARA 2002).

Green sturgeon (FT)

In April 2005, the National Marine Fisheries Service, which oversees recovery of marine and anadramous fish under ESA, listed the southern San Francisco-Sacramento River population of green sturgeon as federally threatened. The northern population, which extends from the Klamath River to the Columbia River estuary, was not included.

Sturgeon is the largest and possibly the oldest fish found in freshwater (ARA 2002). Green sturgeon can reach 7.5 feet in length and weigh up to 350 pounds (ARA 2002). This large anadromous fish ranges from Alaska to Mexico in marine waters and feeds in estuaries and bays from San Francisco Bay to British Columbia (ARA 2002). It spawns in fresh water in the mainstem of large rivers, with the only remaining spawning populations being in the Sacramento and Klamath River basins in California and possibly in the Rogue River in Oregon (ARA 2002). Sturgeons in general are highly vulnerable to habitat alteration such as damming, diversion, and pollution and activities such as over-fishing because of their specialized habitat requirements, the long time it takes them to reach breeding maturity, and their sporadic reproductive success (ARA 2002).

Green sturgeon is recorded from Tomales Bay (Blunt 1980; TBA 1995) and may enter Lagunitas Creek to forage, as do white sturgeon (ARA 2002).

American peregrine falcon (SE, FD)

One of the most widely distributed of warm-blooded terrestrial vertebrates, the peregrine falcon occurs in an amazing diversity of habitats all over the world, which lends credence to its name, which means "wanderer" (White et al. 2002). The peregrine was a cause célèbre of the environmental awakening of the 1970s (White et al. 2002). Although it was thought to be a globally declining and endangered species, numbers were later found to be greater than originally thought, although it was greatly harmed by the widespread use of persistent chemicals such as DDT that lowered reproduction and survival rates (White et al. 2002). By 1970, the peregrine was federally protected in the United States, and peregrines have since made a strong recovery (White et al. 2002).

During the past 20 years, the peregrine falcon population in San Francisco Bay has increased ten-fold, with 10-20 birds in the estuary (SFEP 2004). While the population is increasing, success of reproduction efforts is questionable (SFEP 2004). One factor that has increased this species' popularity is its propensity to nest in very urbanized areas. San Francisco Bay Area has seen the appearance of urban peregrines on a small scale, with birds nesting on or frequenting the Bay Bridge, buildings in downtown San Francisco, and the Golden Gate Bridge (Bell 1994). In Tomales Bay, the peregrine falcon may potentially breed in the Seashore. It has been regularly observed foraging over the Giacomini Ranch and the undiked marsh to the north (ARA 2002).

Sandhill crane (ST)

The sandhill crane is one of only 15 species of cranes in the world and is one of just two crane species native to North America. They are also the oldest living species of bird, with fossils dating back over 6 million years (Save the Bay 2005). One subspecies of crane that spends the winter in California's Central Valley is the greater sandhill crane (Save the Bay 2005). At approximately five feet tall, the greater sandhill crane is one of the tallest birds in the world (Save the Bay 2005). Listed by state as threatened, the survival of the greater sandhill crane is imperiled by habitat loss and degradation (Save the Bay 2005). Within Tomales Bay, sandhill cranes are very rare visitors to wet pastures on the Giacomini Ranch (ARA 2002).

Bank swallow (ST)

The Bank Swallow is one of the most widely ranging of all the species in the swallow family. It is migratory, breeding in western North America on around to eastern Eurasia, while in the winter, it moves south into Central and South America or into Africa and Central Asia. As its name night suggest, the bank swallow is a colonial nesting bird which normally nests along river "banks," but due to human encroachment, they have altered their nest site selection to utilize quarry slag piles and, in San Francisco, sand bluffs in close proximity to freshwater marsh areas.

The species has been listed as threatened by the state because of habitat loss in the Central Valley (Murphy 2006). Once widespread on the coast, this species is now limited to two confirmed colonies, one of which is a single site in the exposed bluffs of the Merced Formation at Fort Funston facing the ocean (Murphy 2006). In Tomales Bay, this species is a rare transient over the Giacomini Ranch, especially in the fall (ARA 2002).

Threats from Non-Native and Invasive Wildlife Species

Non-native and invasive wildlife species can completely alter ecosystem dynamics and the value of aquatic system to native species, as Tomales Bay's neighbor to the east, San Francisco Bay, has demonstrated over the past several decades.

The San Francisco Estuary can now be recognized as the most invaded aquatic ecosystem in North America (Cohen and Carlton 1995). It has 212 introduced species, 69 percent of these are invertebrates, 15 percent are fish and other vertebrates, 12 percent are vascular plants, and 4 percent are protests (Cohen and Carlton 1995). In the period since 1850, the San Francisco Bay and Delta region has been invaded by an average of one new species every 36 weeks, increasing in 1970 to one new species every 24 weeks (Cohen and Carlton 1995). In the state as a whole, nearly half of all freshwater species are introduced (TBWC 2002).

In addition to extirpating native species such as the Sacramento perch from some portions of its range, invasive species are also completely altering the bottom portion of the San Francisco Bay food chain (Cohen and Carlton 1995). Phytoplankton populations in the northern reaches of the Estuary may now be continuously and permanently controlled by introduced clams, with the Asian clam (*Potamocorbula*) filtering the entire water column over the channels more than once per day and over the shallows almost 13 times per day (Cohen and Carlton 1995). In addition to phytoplankton, the Asian clam also consumes bacterioplankton, phytoplankton, and zooplankton (copepods), and so may substantially reduce copepod populations both directly and indirectly (loss of food source). The dramatic decline in copepod population, in turn, could cause collapse in the native copepod-eating mysid shrimp (*Neomysis*), which are one of the major food stocks for salmon and other fisheries (Cohen and Carlton 1995).

Many consider the implications of this large-scale aquatic invasion of San Francisco frightening for Tomales Bay. Currents from Golden Gate can reach some of the estuaries and lagoons along the northern California coast, which is how some surmise that Atlantic cordgrass and its hybrids, non-native competitors with the native Pacific cordgrass, reached Drakes Estero watershed. In addition, ballast water, the primary factor for introduction of many aquatic organisms to San Francisco Bay, can be discharged off the Marin Coast, thereby increasing the potential for introduction of these same species to Tomales Bay. The Tomales Bay All-Taxa Biological Inventory has already documented the presence of at least 28 non-natives among the 2,015 aquatic species recorded during the last three years (Seashore 2005). At least five are deemed to be a serious threat to ecosystem health and native species (Seashore 2005). Other species have spread "overland" through transportation of timber, hay, and fur or were even introduced by humans for food or recreation such as the bullfrog and warmwater fish, respectively (TBWC 2002). Some of the non-native species in the Tomales Bay watershed include the Virginia opossum (*Didelphis virginiana*), the bullfrog, the red fox, Norway rat, black rat (*Rattus rattus*), house mouse (*Mus musculus*), two species, and several fish and bird species (TBWC 2002).

Within the Project Area, several non-native and invasive species have been documented, with perhaps the ones of highest concerns being the green crab (undiked marsh north of Giacomini Ranch), bullfrog (East Pasture, Tomasini Creek, Olema Marsh), and the red fox (Giacomini Ranch-East Pasture and dairy facility). Other non-native species of concern include the yellowfin goby (Lagunitas Creek), turkeys (West Pasture), brackish water or Korean shrimp (Lagunitas and Tomasini Creeks), mosquitofish (Giacomini Ranch East and West Pastures), and crayfish (Giacomini Ranch East and West Pastures). There are also several native species in the Project Area or vicinity whose presence and/or abundance is sometimes considered detrimental, including brown-headed cowbird, a nest parasite found occasionally in Olema Marsh that disturbs the nests of other birds, and common ravens (*Corvus corax*) and American crows (*Corvus brachyrhynchos*), which prey on young of endangered and threatened bird species.

Green crab

One of the aquatic invasive species of most concern is the green crab, which is also present in San Francisco Bay. The green crab is native to the Atlantic coasts of Europe and northern Africa, where it inhabits rocky shores, sand flats, and tidal marshes (ARA 2002). The green crab arrived in San Francisco Bay in 1989-1990 and has since spread as far north as Washington and as far south as Morro Bay (ARA 2002).

The green crab is a food and habitat generalist, capable of eating an extraordinarily wide variety of animals and plants, including bivalve mollusks, polychaetes, and small crustaceans. Indeed, it is its status as a dietary generalist that poses perhaps the greatest threats to native species and their ecosystems. At the turn of the century, this species basically wiped out the soft clam industry of Maine and the surrounding waterways (van Heertum 2002). In California, it has been estimated to cause the loss of as much as 50 percent of Manila clam stocks and substantial decreases in other crab populations (van Heertum 2002). In Bodega Harbor, records show a significant reduction in clam and native shore crab in abundance since the arrival of the green crabs in 1993 (Grosholz et al. 2000). Beside its threat as a predator and potential disruptor of the native food chain, green crab may carry a parasite, the acanthocephalan worm, which can infect local shorebirds (CDFG 2001)*in* ARA 2002).

The green crab arrived in Tomales Bay in 1995-1996. In a study done at one shellfish operation in Tomales Bay, the Manila clam (*Tapes philippinarum*) harvest showed a 40 percent drop after the arrival of green crabs (Biocontrol News and Information 1999; Grosholz and Olin 2000). Numbers were apparently high early on, but declined during some of the El Nino years in 1999-2000. In 2005, green crab numbers in one wetland area in Tomales Bay, Tomasini Estuary near Tomasini Point north of the Giacomini Ranch, were estimated as approximately 8,5000 individuals, with a density of 0.007 to 0.02 crabs per square foot (Pettigrew 2005). These densities are similar to Bodega Bay, which reportedly has densities of 0.15 crabs per square meter, but an order of magnitude lower than densities in European and Atlantic coast estuaries, which has led some

(Yamada 2001) to speculate that competition and environmental factors may be limiting expansion in Pacific coast estuaries (Pettigrew 2005). In the Project Area, the green crab has been sighted primarily in the undiked marsh north of Giacomini Ranch's West Pasture.

Bullfrog

Native to the eastern United States, the bullfrog was introduced to California several times early this century (Storer 1922; Morey 1990). It is now widespread and common in the state (Bury and Luckenbach 1976). The bullfrog is the largest frog in California (Morey 1990), and it may compete with or consume the other amphibians with which it co-exists.

Highly aquatic, bullfrogs are found in quiet waters of ponds, lakes, reservoirs, irrigation ditches, streams, marshes, and other permanent water (Stebbins 1954; Morey 1990). Wright and Wright (1949; Morey 1990) listed shoreline cover and shallow water as important habitats for adults and tadpoles, respectively. Permanent water is often required for the completion of larval development. In California, breeding and egg-laying occur from March to July (Stebbins 1972 *in* Morey 1990). Tadpoles require at least six months to transform, and individuals in many populations overwinter as tadpoles and transform during their second year (Treanor and Nicola 1972) *in* Morey 1990).

Adults are opportunistic feeders taking both aquatic and terrestrial prey items. Invertebrates are the primary food of bullfrogs ((Frost 1935; Korschgen and Moyle 1955; Cohen and Howard 1958; Taylor and Michael 1971; Morey 1990), but vertebrate prey such as fish, salamanders, frogs (including bullfrogs) and tadpoles, spadefoot toads, snakes, turtles, birds, and mice are also taken. Moyle (1973) *in* Morey 1990) suggested that bullfrogs are responsible for the elimination of the red-legged frog from the floor of the Central Valley and adjacent Sierra foothills, and for reduction in the range of the yellow-legged frogs. Supporting evidence for this is sparse (Morey 1990), but bullfrogs are believed to have played some role in the decline of California red-legged frogs and other native amphibians.

Red fox

The red fox is widely distributed in lowlands in central and southern California (Johnson 1990). Introduced populations inhabit Sacramento and San Joaquin valleys and scattered coastal and inland locations from Sonoma County south to Monterey County, and east to Stanislaus County, as well as in Ventura, Los Angeles, and Orange counties (Johnson 1990). The red fox hunts small and medium-sized mammals, ground squirrels, gophers, mice, marmots, woodrats, pikas, and rabbits, but it is its affinity for hunting federally and state endangered ground-nesting species such as California clapper rail and California black rail that have raised concerns about its increasing numbers within the San Francisco Bay region and other coastal areas with rail populations (San Francisco Bay Estuary Goals Project 1999). The impact of this species on rails and other ground-nesting species is increased, because most of the remaining marshes are leveed or near levees, which the red fox readily use to access rails, and the red fox can swim, unlike its native counterpart (Goals Project 1999).

Fish and Wildlife Resources and Wetland Functionality

One of the most important or certainly most publicized functions for wetlands is to provide breeding, nesting, foraging, and refugia habitat for wildlife, as well as to support wildlife species in distant locations through export of carbon and potential food sources. Tomales Bay is tremendously important to estuarine and marine species. Despite diking and other agricultural activities, the Project Area is also currently important to wildlife, particularly avian species, although it also provides support for amphibian and fish species currently, as well. Much of the existing value of the Project Area to wildlife probably results from the fact that it is already wetland, although the diversity of wetland and upland habitats within the Project Area and immediate vicinity also appears to play a crucial role in increasing species diversity. Its value may be enhanced, as well, by the fact that the Project Area falls within one of the largest estuarine transition zones in Tomales Bay, a dynamic and often biotically diverse interface between saltwater and freshwater environments.

Most of the species detected in or around the Giacomini Ranch occurred on the perimeter of the Ranch itself, where there is more habitat diversity.

From a broad perspective, most of the species detected in or around the Giacomini Ranch occurred on the perimeter of the Ranch itself, where there is more habitat diversity. This habitat diversity comes primarily from the juxtaposition between not only freshwater and saltwater environments created by abundant groundwater and fluvial sources at the edge of an estuary, but between the wetland and upland environments that have been created by uplift along the San Andreas Fault and other geological processes. However, this habitat diversity also appears to stem in part from the fact that many of the Ranch's "edges" are not as highly managed for agriculture. Some of the most frequented wildlife areas on the Ranch are the West Pasture freshwater marsh, the ruderal or unmanaged field in the northern portion of the West Pasture, the riparian corridor and seep-fed meadows along Sir Francis Drake Boulevard, the riparian scrub habitat at the Green Bridge County Park and on the Point Reyes Mesa, and the shallow shorebird habitat that has developed in one of the East Pasture's ruderal fields (ARA 2002).

More than 300 acres of the 550 acres of pastures and lowland areas in the Giacomini Ranch East Pasture are actively managed though irrigation, mowing, manure spreading, grazing, and other activities. Wildlife surveys found few species actively using these managed pastures, and the few species that did were sometimes prevented from successfully because of agricultural activities (ARA 2002). The primary species using the Giacomini Ranch East Pasture were roosting waterfowl or waterbirds and occasionally deer, red fox, sparrows, swallows, and small mammals such as voles and gophers (ARA 2002). Within these monotypic pastures, drainage ditches and ditched sloughs did increase habitat diversity -- and thereby species diversity -- somewhat, attracting northwestern pond turtle and depauperate fish and invertebrate communities in addition to the occasional southwestern river otter, waterbird and waterfowl, and California red-legged frog. While non-native species are present in the ditches such as mosquitofish, the ditches and pastures do not appear to be heavily managed through use of herbicides or pesticides, which may increase diversity relative to other very highly managed wetlands.

Olema Marsh is not as highly managed as the Giacomini Ranch, which has probably increased its relative value to wildlife. Olema Marsh offers some of the same habitat diversity as Giacomini Ranch, because the marsh borders the Inverness Ridge, which contributes upland habitat, as well as groundwater and fluvial influences that sustain both the marsh and a broad riparian zone. The overall importance of this marsh to wildlife is difficult to gauge, because of the complexities involved in comprehensively surveying it. Certainly, its value to particular types of birds has been well-documented, and it does support California red-legged frog, but use by fish and invertebrates, some of which are also special status species, is uncertain. Based on historic maps, this area might have once attracted special status fish and invertebrates such as tidewater goby, coho salmon, and perhaps in freshwater portions or in very wet years, California freshwater shrimp, but these species have not been sighted in the marsh or upstream watershed. The status and future of steelhead in this system still remains questionable due to problems with the Levee Road and Bear Valley Road culverts, as well as potentially the lack of a defined flow path through the marsh (KHE 2006b).

On a larger scale, hydrologic disconnection of both the Giacomini Ranch and Olema Marsh from Lagunitas Creek has substantially decreased the potential of these areas to support or improve conditions for marine and estuarine species in other areas of Tomales Bay. The low numbers and diversity of fish and invertebrate species that do occur within the Project Area are largely unavailable to aquatic organisms within the Bay, thereby decreasing the Project Area's overall value to wildlife. Obviously, some waterbirds and raptors, as well as southwestern river otter, do forage in the Giacomini Ranch but the contribution to the larger food web within the Bay has been minimized by levees, culverts, and other hydrologic alterations. The lack of hydrologic connectivity between creek and floodplain also limits the ability of these wetlands to export carbon and to improve water quality, both of which can affect Tomales Bay wildlife. Poor water quality not only impacts the oyster industry, but it may negatively affect both diving ducks and fish-eating waterbirds, which forage on benthic invertebrates susceptible to contamination in sediment (diving ducks) or require high visibility to sight prey (waterbirds; Kelly and Tappen 1998). In addition, excessive amounts of sediment in flood flows can literally "smother" populations of benthic invertebrates that act as food source for shorebirds, which may account for several years of sharp mid-winter declines observed in certain shorebird species numbers in Tomales Bay following very large storm events (Kelly 2001).